Community Experience Distilled

Web Development with MongoDB and Node.js

Build an interactive and full-featured web application from scratch using Node.js and MongoDB

Jason Krol

[PACKT] PUBLISHING open source* community experience distilled

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About the Author

Jason Krol is a passionate web developer with over 15 years of professional experience in creating highly interactive web applications using the latest in both client and server technologies.

Previously, Jason spent a majority of his career working with the Microsoft stack using ASP.net. Recently, he has been focusing on developing Single Page Applications using JavaScript in the full stack with Node.js, MongoDB, and Backbone.js. After co-owning and running a successful web development agency for a number of years, Jason recently jumped back into the world of full time employment.

When not writing code for work or side projects, he blogs about his development experiences and opinions at `www.KrolTech.com` and on Twitter at `@ShortTompkins`. He loves spending his free time with his wife and 8-year-old son.

I would like to specially thank my wonderful wife for putting up with me and for always being there to push me whenever I doubt myself.

About the Reviewers

Anthony Gilardi is a full stack JavaScript developer at one of the top e-mail marketing companies and a mobile technology enthusiast and app developer. He started programming at the age of 12 on a Sinclair ZX80. During his formative years, he worked on fighter jets and jet engines in the United States Air Force. He later earned a Bachelor of Science degree from Rutgers University in Biochemical Engineering. Programming, however, was his true passion, so he worked for over a decade doing Microsoft development in the pharmaceutical industry. He is now fully focused on working with JavaScript technologies for web and mobile development in what he considers the most exciting time to be a JavaScript developer.

Anthony's personal passion and creative energy is focused toward his *appMite* brand creating mobile hybrid apps. The introduction of Palm webOS and the Mojo framework ignited his interest in using JavaScript for mobile apps. He has created several hybrid apps, most notably his lifestyle application named lifeMite, which was released for Android, iOS, Kindle, and Nook. He is excited about the future of hybrid apps and learning budding technologies such as Polymer and Web Components.

If he doesn't know it, he learns it. If he doesn't understand it, he learns it more. Anthony loves creative whims. This is something he has always had but has been reinforced by his wife and three children who are always creating and learning. He doesn't ever want to lose that creative drive.

Outside of technology, he is a husband and father of three, who loves camping, walking, and finding obscure places to meditate. If you wish to see his latest apps or programming projects, visit `http://appmite.com`, or if you wish to read his personal ventures, please visit `http://journeysimple.com`.

James O'Brien is a software engineer with over 15 years of experience as a web technologist, specializing in professional web application development with technologies, including HTML5, JavaScript, CSS, Backbone.js, C#, ASP.NET, MVC, PHP, and SQL Server. He also has experience in graphic design and online marketing.

James is a Philadelphia native and is currently Manager for Web Development and Interactive Marketing at NextGen Healthcare. Besides this, he co-created Fill The Part (`fillthepart.com`) and runs it. Launched in 2012, it gives you a unique entertainment website experience: the chance to cast (or recast) a movie the way you'd want to see it. His other interests include movies (of course), playing basketball, and gaming. He's a proud husband and father.

Mithun Satheesh is an open source enthusiast and a full stack web developer from India. Starting his career as a PHP developer, he has over 4 years of experience in web development both in frontend and backend programming.

He has written a couple of libraries on Node.js and published them on npm, which have got a considerable user base. One of these is called *node-rules*, a forward-chaining rule engine implementation written initially to handle transaction risks on `bookmyshow.com`, one of his former employers. He is a regular on programming sites such as Stack Overflow and loves contributing to the open source world.

Apart from programming, he is also interested in experimenting with various PaaS solutions. He has a number of applications listed in the developer spotlight of PaaS providers such as Red Hat's OpenShift.

You can follow him on Twitter at `@mithunsatheesh`.

I would like to thank my parents for allowing me to live the life that I wanted to live. I am thankful to all my teachers for whatever knowledge I have gained in my life.

Peter Shannon is a husband and father who moonlights as a software engineer and data scientist. Originally a chemist, he found his passion for software engineering in high performance computing and computational chemistry—which never really became his forte. Now, he spends most of his time writing data-driven tools, staring at graphs, and occasionally doing math. When relaxing, he enjoys watching Star Trek Deep Space Nine reruns and pondering about life's biggest questions.

I would like to thank the Flying Spaghetti Monster for the noodly strength to review this book.

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Preface

My goal while writing *Web Development with MongDB and Node.js* was simple: to empower you, the reader, with the tools and knowledge to be able to create web applications from scratch using Node.js and MongoDB.

In this book, we take a hands-on approach to building a complete, real-world, interactive web application. Each chapter will build upon the previous one, exposing new concepts, technologies, and best practices until finally ending with a completed application deployed to the cloud. Every line of code will be covered, and you are expected to code along with each chapter. Doing so will give you valuable insight into the world of web development using Node.js.

By the end of this book, I hope you have the expertise to tackle any project using Node.js and MongoDB and are limited only by your imagination!

What this book covers

Chapter 1, *Welcome to JavaScript in the Full Stack*, introduces you to the world of full stack JavaScript development and reviews what to expect in the remainder of the book.

Chapter 2, *Getting Up and Running*, walks you through the necessary steps to download, install, and configure your development environment.

Chapter 3, *Node and MongoDB Basics*, is a brief introduction to the basics of JavaScript, Node.js, and MongoDB.

Chapter 4, *Writing an Express.js Server*, introduces you to the Express.js Node.js Web Framework and is a walkthrough of the code necessary to write the main application server.

Chapter 5, *Dynamic HTML with Handlebars*, teaches you how to create dynamic HTML pages using Handlebars, the popular template-rendering engine.

Chapter 6, *Controllers and View Models*, walks you through writing the Controllers and View Models for the main application, the core of the application's functionalities.

Chapter 7, *Persisting Data with MongoDB*, continues with our Controllers and View Models, where we wrap all of the logic using Mongoose with MongoDB as the main data layer for the application.

Chapter 8, *Creating a RESTful API*, reviews the concepts behind REST APIs and introduces the Postman REST Client tool to test and interact with our own custom Node.js API.

Chapter 9, *Testing Your Code*, introduces the tools and techniques to write automated tests for our Node.js code.

Chapter 10, *Deploying with Cloud-based Services*, is a step-by-step walkthrough of deploying your application to a number of popular cloud-based hosting services such as Heroku, Microsoft Azure, and Amazon's AWS.

Chapter 11, *Single Page Applications with Popular Frontend Frameworks*, takes a look at the current trend in thick client applications by learning more about popular frontend single application frameworks such as Ember.js, AngularJS, and Backbone.js. Additionally, you will learn about the popular build tools frontend developers use to make their lives easier.

Chapter 12, *Popular Node.js Web Frameworks*, takes a look at some very popular and robust alternatives such as Meteor and Sails, even though Express.js is one of the most popular web frameworks for Node.

What you need for this book

In this book, the following software will be required:

- Operating systems:
    - Windows XP or superior
    - Mac OS X or superior
    - Linux

- Miscellaneous:
    - A standard text editor of choice
    - A web browser, preferably Google Chrome
- A command-line terminal of choice

Who this book is for

This book is designed for developers of any skill level that want to get up and running using Node.js and MongoDB to build full-featured web applications. A basic understanding of JavaScript and HTML is the only requirement for this book.

Conventions

In this book, you will find a number of styles of text that distinguish between different kinds of information. Here are some examples of these styles, and an explanation of their meaning.

Code words in text, database table names, folder names, filenames, file extensions, pathnames, dummy URLs, user input, and Twitter handles are shown as follows: "Make sure you've npm installed all of the required modules for this chapter and that they are saved to your `package.json` file."

A block of code is set as follows:

```
models.Image.aggregate({ $group : {
    _id : '1',
    viewsTotal : { $sum : '$views' }
}}, function(err, result) {
    var viewsTotal = 0;
    if (result.length > 0) {
        viewsTotal += result[0].viewsTotal;
    }
    next(null, viewsTotal);
});
```

When we wish to draw your attention to a particular part of a code block, the relevant lines or items are set in bold:

```
.upload-button {
    border-bottom: solid 2px #005A8B;
    background: transparent $sprite-bg no-repeat;
    @include radius(4px);
    cursor: pointer;
```

Any command-line input or output is written as follows:

```
$ node server.js
Server up: http://localhost:3300
Mongoose connected.
```

New terms and **important words** are shown in bold. Words that you see on the screen, in menus or dialog boxes for example, appear in the text like this: "Users demand more from their apps these days, and if you think about the application we've written, the **Like** button is a perfect example."

Warnings or important notes appear in a box like this.

Tips and tricks appear like this.

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1
Welcome to JavaScript in the Full Stack

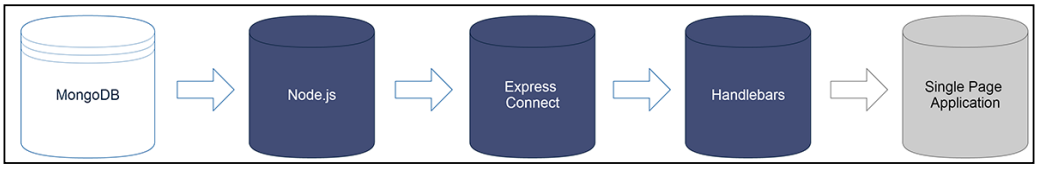
What an exciting time to be a JavaScript developer! What was once only considered a language to add enhancements and widgets to a webpage has since evolved into its own full-fledged ecosystem. I believe Atwood's law says it best— *any application that can be written in JavaScript, will eventually be written in JavaScript*. While this quote dates back to 2007, it's never been more true than today. Not only can you use JavaScript to develop a complete single-page web application such as Gmail, but you will also see how we can achieve the following projects with JavaScript throughout the remaining part of the book:

- How to completely power the backend using Node.js and Express.js
- How to persist data with a powerful database like MongoDB
- How to write dynamic HTML pages using Handlebars.js
- How to deploy your entire project to the cloud using services like Heroku and AWS

With the introduction of Node.js, JavaScript has officially gone in a direction that was never even possible before. Now, you can use JavaScript on the server, and you can also use it to develop full-scale enterprise-level applications. When you combine this with the power of MongoDB and its JSON-powered data, you can work with JavaScript in every layer of your application.

One of the great advantages of developing with JavaScript in the "full stack" of a web application is that you are using a consistent language and syntax. Frameworks and libraries are no longer exclusive only to the frontend or backend but can be integrated into other layers of the application as well.

Underscore.js is an extremely popular JavaScript library to work with collections that is used equally on the backend with Node.js as much as on the frontend directly within the browser.



JavaScript in the full stack of a web application

Node.js changed JavaScript forever

Back in 2009, Ryan Dahl gave a presentation at JSConf that changed JavaScript forever. During his presentation, he introduced Node.js to the JavaScript community, and after a roughly 45-minute talk, he concluded it, receiving a standing ovation from the audience in the process. He was inspired to write Node.js after he saw a simple file upload progress bar on Flickr, the image-sharing site. Realizing that the site was going about the whole process the wrong way, he decided that there had to be a better solution.

As stated on the Node.js homepage, the goal of Node is *to provide an easy way to build scalable network programs*. It achieves this by providing an event-driven, nonblocking IO model that is extremely lightweight. Compared to traditional web-serving technologies that require a new CPU thread for every connection to the server that would eventually max out the systems resources, Node instead uses a single thread but doesn't block the I/O of the CPU. Thus, this allows Node to support tens of thousands of concurrent connections. It's for this very reason that Node is so popular with high-traffic web applications.

To see an example of just how lightweight Node can be, let's take a look at some sample code that starts up an HTTP server and sends **Hello World** to a browser:

```
var http = require('http');
http.createServer(function (req, res) {
  res.writeHead(200, {'Content-Type': 'text/plain'});
  res.end('Hello World\n');
}).listen(8080, 'localhost');
console.log('Server running at http://localhost:8080');
```

A few basic lines of code are all it takes to write a complete Node application. Running it with a simple `node app.js` command will launch an HTTP server that is listening on port 8080. Point any browser to `http://localhost:8080`, and you will see the simple output **Hello World** on your screen! While this sample app doesn't actually do anything useful, it should give you a glimpse of the kind of power you will have while writing web applications using Node.js.

At its core, Node is very low-level. It consists of a small set of modules that do very specific things and do them very well. These modules include tools to work with the file system, networking with TCP and HTTP, security, and streams.

Asynchronous callbacks

One of the most powerful features of Node is that it is event-driven and asynchronous. Code gets executed via callback functions whenever an event is broadcast. Simply put, you assign a callback function to an event, and when Node determines that the event has been fired, it will execute your callback function at that moment. No other code will get blocked waiting for an event to occur. Consider the following example to see asynchronous callbacks in action:

```
console.log('One');
console.log('Two');
setTimeout(function() {
    console.log('Three');
}, 2000);
console.log('Four');
console.log('Five');
```

Downloading the example code

You can download the example code files for all Packt books you have purchased from your account at `http://www.packtpub.com`. If you purchased this book elsewhere, you can visit `http://www.packtpub.com/support` and register to have the files e-mailed directly to you.

In a typical synchronous programming language, executing the preceding code will yield the following output:

```
One
Two
... (2 second delay) ...
Three
Four
Five
```

However, in JavaScript and Node, the following output is seen:

```
One
Two
Four
Five
... (approx. 2 second delay) ...
Three
```

The function that actually logs `Three` is known as a callback to the `setTimeout` function.

Node Package Manager

Writing applications with Node is really enjoyable when you realize the sheer wealth of information and tools at your disposal! Using Node's built-in package manager *npm*, you can find literally tens of thousands of modules that can be installed and used within your application with just a few keystrokes! You can view the library of available modules by visiting `http://npmjs.org`. Downloading and installing any module within your application is as simple as executing the `npm install package` command. Have you written a module that you want to share with the world? Package it up using npm, and upload it to the public `npmjs.org` registry just as easily! Not sure how a module works that you downloaded and installed? The source code is right there in your projects' `node_modules/` folder waiting to be explored!

Networking and file IO

In addition to the powerful nonblocking asynchronous nature of Node, it also has very robust networking and filesystem tools available via its core modules. With Node's networking modules, you can create server and client applications that accept network connections and communicate via streams and pipes.

Not just on the web

Node isn't just for web development! It can be a powerful solution to create command-line tools as well as full-featured locally run applications that have nothing to do with the Web or a browser. Grunt.js is a great example of a Node-powered command-line tool that many web developers use daily to automate everyday tasks such as build processes, compiling CoffeeScript, launching Node servers, running tests, and more.

In addition to command-line tools, Node has recently become increasingly popular among the hardware crowd with the Nodebots movement. Johnny-Five and Cylon.js are two popular Node libraries that exist to provide a framework to work with robotics.

Real-time web with Socket.io

Node achieves real-time communication with Socket.io. Using Socket.io, you can create features such as instant collaboration, which is similar to multiuser editing in Google Docs. What was once achieved using cumbersome (and not real-time) long polling can now be achieved using WebSockets. While WebSockets is a feature that is only supported in modern browsers, Socket.io also features seamless fallback implementations for legacy browsers.

Using this lightweight core, everything else is left to the developer—but don't let that scare you. The beauty of working with Node is that there is a thriving community developing and releasing modules every day via npm. As of this writing, npm has over 61,000 packages available! Throughout this book, we will use some of the most popular packages that help make writing web applications fun and easy!

The NoSQL movement

The term *NoSQL* has come to mean any kind of database that doesn't adhere to the strict structures of a typical relational database such as Microsoft SQL, MySQL, PostgreSQL, and so on. With a relational database, you are required to define ahead of time the exact structure of your schema. This means that you must have defined the exact number of columns, length, and datatype for every field in a table, and that each field must always match that exact set of criteria.

With a NoSQL database server such as MongoDB, records are stored as JSON-like documents. A typical document (record) in a MongoDB collection (table) might look like the following code:

```
$ mongo
> db.contacts.find({email: 'jason@kroltech.com'}).pretty()

{
    "email" : "jason@kroltech.com",
    "phone" : "123-456-7890",
    "gravatar" : "751e957d48e31841ff15d8fa0f1b0acf",
    "_id" : ObjectId("52fad824392f58ac2452c992"),
    "name" : {
```

```
            "first" : "Jason",
            "last" : "Krol"
        },
        "__v" : 0
    }
```

One of the biggest advantages of using a NoSQL database server such as MongoDB is that it has a dynamic schema system, allowing records in a collection to be completely different from one another.

Some advantages of working with MongoDB are:

- Dynamic schema design
- Fast querying and indexing
- Aggregate framework
- Sharding and replication

In addition, as MongoDB was written using a JSON-like document structure, JavaScript becomes a powerful tool when working with queries and the interactive shell *mongo*. Like Node, MongoDB is also built for high performance, making it a great counterpart for building ever demanding, high traffic web and mobile applications. Depending on your exact needs, MongoDB may or may not be the right solution for your application. You should truly weigh the pros and cons of each technology before making a decision to determine which technology is right for you.

Node and MongoDB in the wild

Both Node and MongoDB are extremely popular and active in the development community. This is true for enterprises as well. Some of the biggest names in the Fortune 500 space have fully embraced Node to power their web applications. This is due in large part to the asynchronous nature of Node, which makes it a great alternative for high traffic, high IO applications such as e-commerce websites and mobile applications.

The following is just a small list of some big companies that are working with Node:

- PayPal
- LinkedIn
- eBay
- Walmart
- Yahoo!

- Microsoft
- Dow Jones
- Uber
- New York Times

MongoDB's use in the enterprise sector is equally as impressive and wide reaching with an increasing number of companies adopting the leading NoSQL database server, such as:

- Cisco
- Craigslist Inc.
- Forbes
- FourSquare
- Intuit
- McAfee
- MTV
- MetLife
- Shutterfly
- Under Armour

What to expect from this book

The remainder of this book is going to be a guided tour that walks you through creating a complete data-driven website. The website we create will feature almost every aspect of a typical large-scale web development project. At its core, it will be powered by Node.js using a popular third-party framework called Express, and it will persist data using MongoDB.

In the first few chapters, we will cover the groundwork involved in getting the core of the server up and serving content. This includes configuring your environment so you are up and running with Node and MongoDB, and a basic introduction to the core concepts of both technologies. Then, we will write a web server from scratch powered by ExpressJS that will handle serving all of the necessary files for the website. From there, we will work with the Handlebars template engine to serve both static and dynamic HTML webpages. Diving deeper, we will make the application persistent by adding a data layer where the records for the website will be saved and retrieved via a MongoDB server. We will cover writing a RESTful API so that third parties can interact with your application. Finally, we will go into detail examining how to write and execute tests for all of your code.

Wrapping up, we will take a brief detour as we examine some popular, emerging frontend technologies that are becoming increasingly popular while writing single-page applications. These technologies include Backbone.js, Angular, and Ember.js.

Last but not least, we will go into details of how to deploy your new website to the Internet using popular cloud-based hosting services such as Heroku and Amazon Web Services.

Summary

In this chapter, we reviewed what is to be expected throughout the remainder of this book. We discussed the amazing current state of JavaScript and how it can be used to power the full stack of a web application. Not that you needed any convincing in the first place, but I hope you're excited and ready to get started writing web applications using Node.js and MongoDB!

Next up, we will set up your development environment and get you up and running with Node, MongoDB, and npm as well as write and launch a quick first Node app that uses MongoDB!

2
Getting Up and Running

The first thing you need to take care of is to make sure your development environment is equipped with the necessary requirements in order for you to use both Node and MongoDB while launching the apps you write.

In this chapter, we will cover the following topics:

- Installing and testing Node.js
- Installing, configuring, and testing MongoDB
- Writing and launching a simple app

Environment assumptions and requirements

For the remainder of this book, I will assume that you are using either a Mac with OS X, Linux, or Windows 7 or 8. You will also need superuser and/or administrator privileges on the computer, as you will be installing the Node and MongoDB server software. The code and examples after this chapter will all be OS agnostic and should work in any environment, assuming you have taken the steps I outline here so that you are prepared ahead of time.

You will need a good text editor to write and edit the code. Any editor of your liking will do. Personally, I am a huge fan of Sublime Text 3 (`http://sublimetext.com`). It is a simple, lightweight editor that has great color-coding syntax support. However, its true power comes from the unlimited plugins made available by other developers. There is literally a plugin for everything in Sublime! VI and Notepad are also good options if you want to stay super lightweight.

Finally, you're going to need access to the command line. Linux and Mac have access to the command line via the Terminal program. A great alternative on Mac is iTerm2 (`http://iterm2.com`). For Windows, the default command-line program (navigate to **Start** | **Run** and insert `command`) works but it isn't the best. A great alternative to the terminal program on Windows is ConEmu (`http://conemu.codeplex.com`). In addition to the standard Windows command line, ConEmu allows you to run PowerShell—an alternative in a Windows environment that replicates a lot of the standard functionality found in the Linux shell. A great introduction to ConEmu, PowerShell, and the command line in general for Windows users can be found at `http://www.hanselman.com/blog/ConEmuTheWindowsTerminalConsolePromptWeveBeenWaitingFor.aspx`.

For the remainder of this book, any time I reference a command line or prompt, it will look like the following:

```
$ command -parameters –etc
Output from above command will typically appear as the following lines.
```

With the command line, actual commands will always begin with `$` to denote that this is the prompt. Lines that follow and do not begin with `$` will denote output from the previous command.

Installing Node.js

Node.js can be easily installed by visiting the official Node website and accessing the Downloads section at `http://nodejs.org/download/`.

Once there, be sure to download the correct version depending on your OS and CPU (32 bit or 64 bit).

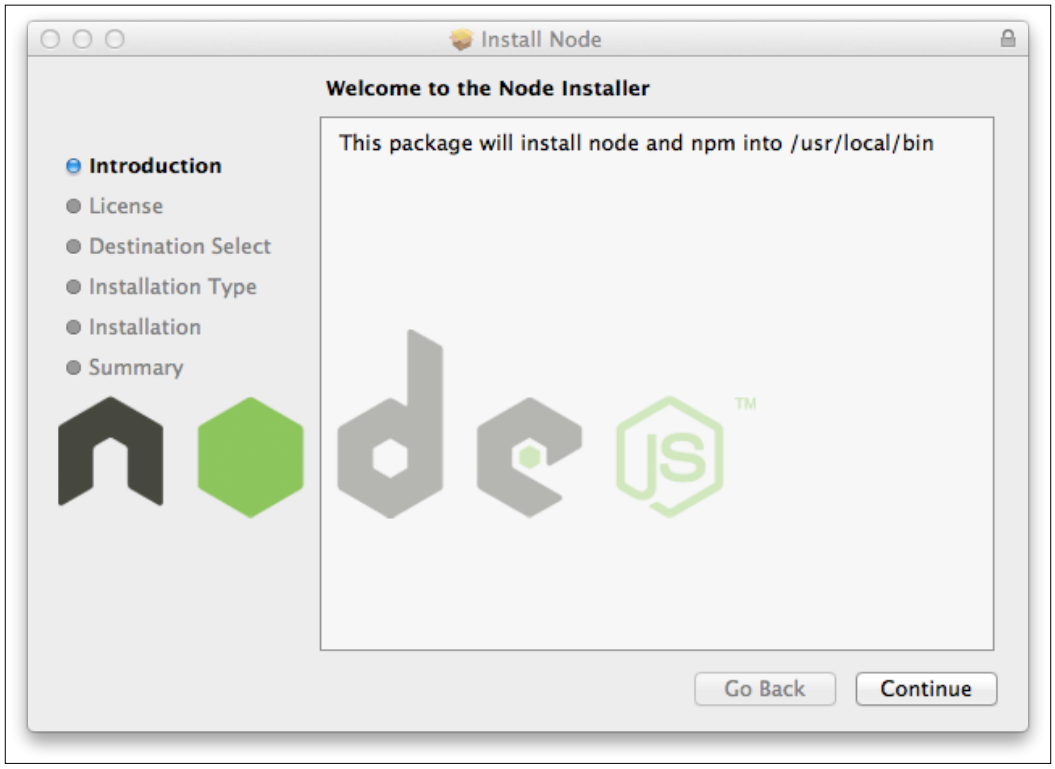
Mac OS X installation instructions

To determine which version of Node you want to download, you first need to determine your processor type: 32 or 64 bit. You can do this by executing the following command from a terminal:

```
$ sysctl hw | grep 64bit
hw.cpu64bit_capable: 1
```

If you get `1` in the response, then you are running a 64-bit CPU. If the response is `0`, then you are running the 32-bit version. Fortunately, there is a universal installer specifically for Mac available from the Node website; however, if you wanted to download the binary, at least now you know which to get.

Once the download is complete, double-click on the `.pkg` file, which will launch the Node installer (as shown in the following screenshot):



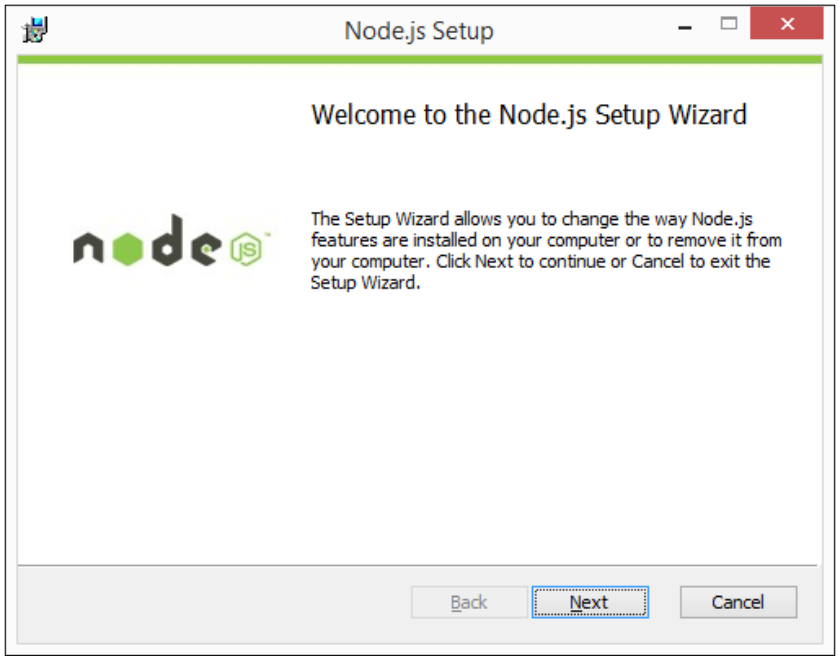
Proceeding through each step of the wizard should be fairly self-explanatory. Note that the installation of Node also includes the installation of npm, Node's Package Manager.

Windows 7 or 8 installation instructions

To determine which version of Node you want to download, you first need to determine your processor type; that is, 32 or 64 bit. You can do this by executing the following command on the command prompt:

```
$ wmic os get osarchitecture
OSArchiecture
64-bit
```

Once the download is complete, double-click on the `.msi` file that will launch the Node installer (as shown in the following screenshot):



Proceed through all the steps of the wizard. When you get to the custom setup screen, you will notice that the installation wizard will install not only the Node.js runtime, but also npm and configure a PATH variable (so that node and npm can be executed from any folder via the command line).

Linux installation instructions

As there are so many different flavors and distributions of Linux available, installing Node isn't quite straightforward. However, if you're running Linux to begin with, then you are more than aware of this and probably comfortable with a few extra steps.

To determine your CPU type, whether 32 or 64 bit, execute the following command from the command line:

```
$ uname -m
x86_64
```

This command will output the chipset architecture and processor type (that is, Intel x86 with 64 bit).

Joyent has an excellent wiki on how to install Node on Linux using the many different package manager options available. You can read that wiki by visiting `https://github.com/joyent/node/wiki/Installing-Node.js-via-package-manager`.

For Ubuntu 12.04 to 13.04 as an example, the steps to install Node would be as follows:

```
$ sudo apt-get update
$ sudo apt-get install python-software-properties python g++ make
$ sudo add-apt-repository ppa:chris-lea/node.js
$ sudo apt-get update
$ sudo apt-get install nodejs
```

Once those steps have completed, both Node and npm should be installed on your system.

Confirming successful Node.js installation

Now that Node has been installed on your system, let's run a quick test to ensure everything is working properly.

Access the command line via your Terminal program and execute the following command:

```
$ node --version
v0.10.26
$ npm --version
1.4.3
```

Assuming your Node installation was successful, you should see the version number that was installed in the output on the screen right under the command you executed.

Note that your version numbers will most likely be more recent than those printed in the preceding example.

You can also launch the Node repl, a command-line shell that lets you execute JavaScript directly:

```
$ node
> console.log('Hello world!')
Hello World!
Undefined
[press Ctrl-C twice to exit]
```

Bookmarking the online documentation

Be sure to point your browser to the following online documentation for Node and bookmark it, as it will undoubtedly become a resource that you will want to access on a regular basis:

`http://nodejs.org/api/`

Also, check out the npm registry, outlined in the following link, where you can find tens of thousands of modules available for Node developers:

`http://npmjs.org`

Installing the MongoDB server

MongoDB can also be easily downloaded by visiting the official MongoDB website and accessing the Downloads section at `http://www.mongodb.org/downloads`.

Depending on the version of MongoDB you downloaded, you will want to replace `<version>` in the following sections with the appropriate version number that matches your file.

Once there, be sure to download the correct version depending on your OS and CPU (32 or 64 bit). You should have determined this in the previous steps when you downloaded and installed Node. For Windows users, you can opt to download the MSI installer file, which will make installation much simpler.

Mac OS X installation instructions

After completing the download, open and extract the contents of the `.tgz` file. You will want to move the extracted contents to a `/mongodb` destination folder. You can do this either via the Finder or the command line, whichever you prefer.

Alternatively, MongoDB can be very easily installed using Homebrew. Homebrew is referred to as *the missing package manager for OS X*. If you don't have Homebrew installed, you can do so by visiting `http://brew.sh` and following the guide. The remainder of this section of the chapter assumes you are not using Homebrew, but if you do, you can skip most of it by simply executing:

```
$ brew update
$ brew install mongodb
```

Then, you can proceed directly to the testing section of this chapter for MongoDB.

The following commands will create a `mongodb` folder, and copy the contents of the extracted tgz file to that folder:

```
$ sudo mkdir -p /mongodb
$ cd ~/Downloads
$ cp -R -n mongodb-osx-x86_64-<version>/ /mongodb
```

You will want to ensure that the location of the MongoDB binaries is configured in your environment PATH so that you can execute `mongod` and `mongo` from any working directory. To do this, edit the `.bash_profile` file in your home folder (`~/`) and append the location for MongoDB to it. Your `.bash_profile` file should look something like the following code:

```
export PATH=~/bin:/some/of/my/stuff:/more/stuff:/mongodb/bin:$PATH
```

If you don't have this line or are missing `.bash_profile` completely, you can create one easily by executing the following line:

```
$ touch .bash_profile
$ [edit] .bash_profile
export PATH=$PATH:/mongodb/bin
```

You will more than likely have a lot more than what I have in the preceding line. The important thing is that you append `:/mongodb/bin:` before `$PATH` at the end. The `:` is a delimiter between different paths (so it's likely that you will be adding your path to the end of an existing list but before the trailing `$PATH`).

Next, you need to create a default data folder that MongoDB will use to store all data documents. From the command line, execute the following:

```
$ sudo mkdir -p /data/db
$ chown 'id -u' /data/db
```

Once the files have been properly extracted to the `/mongodb` folder and the two data folders created, you can start the MongoDB database server by executing the following command from the command line:

```
$ mongod
...
Sun Mar 16 12:26:58.885 [initandlisten] waiting for connections on port
27017
```

This will dump a bunch of log statements while the server starts up, but ultimately it ends with a line that says it's waiting for connections on port 27017.

That's it! Your MongoDB server is up and running. You can type in `Ctrl-C` to cancel and shut down the server.

It's important to note that because you are performing local development on your development machine and not a production server, you don't require the MongoDB server to be always up and running. This would be unnecessary strain on your machine during the majority of the time you're not developing against the server. Because of this, throughout the remainder of this book, you will always be required to manually launch the server every time you launch code that expects to connect to a MongoDB server. If you want, you can certainly configure MongoDB to run locally as a service and be "always up", but instructions to do so are beyond the scope of this chapter.

Windows 7 or 8 installation instructions

After completing the download, the MongoDB website will automatically redirect you to a landing page with a link to the Windows Quick Start guide: `http://docs.mongodb.org/manual/tutorial/install-mongodb-on-windows/`.

It is highly recommended that you follow this guide as it will be the most up to date and will generally be more detailed than what I can provide here.

During the installation, MongoDB will be installed to `C:\Program Files\MongoDB 2.6 Standard\` by default—feel free to change this location to `c:\mongodb\` as that will make it easier to launch MongoDB from the command line in future.

Next, you need to create a default data folder that MongoDB will use to store all data documents. Using Windows Explorer or the command prompt, whichever you are most comfortable with, create the `C:\data` folder and then `C:\data\db`:

```
$ md data
$ md data\db
```

You can now start the MongoDB database server by executing the following command from a prompt:

```
$ c:\mongodb\bin\mongod.exe...
Sun Mar 16 16:58:05.182 [initandlisten] waiting for connections on port 27017
```

As you will manually be executing this command quite a lot throughout the remainder of this book (as well as the remainder of your MongoDB development in general), it will be easier to configure this path in your environment variables so that you can simply execute `mongod` without requiring the full path. You can learn more about this by visiting `http://www.howtogeek.com/118594/how-to-edit-your-system-path-for-easy-command-line-access/`.

This should dump a bunch of log statements while the server starts up, but ultimately it should end with `waiting for connections on port 27017`.

That's it! Your MongoDB server is up and running. You can type in `Ctrl-C` to cancel and shutdown the server.

It's important to note that as you are performing local development on your development machine and not a production server, you don't need the MongoDB server to always be up and running. This will be unnecessary strain on your machine for the majority of the time you're not developing against the server. Because of this, throughout the remainder of this book, it will always be a requirement that you manually launch the server every time you launch code that expects to connect to a MongoDB server. If you want, you can certainly configure MongoDB to run locally as a service and be "always up", but instructions to do so are beyond the scope of this chapter.

Linux installation instructions

Once again we are faced with a slightly more challenging installation process with Linux versus Windows or Mac. The official website has great instructions on how to install MongoDB on a number of different Linux distributions: `http://docs.mongodb.org/manual/administration/install-on-linux/`.

We will continue to use Ubuntu as our flavor of choice, and use the APT package manager for the installation:

```
$ sudo apt-key adv --keyserver hkp://keyserver.ubuntu.com:80 --recv
7F0CEB10

$ echo 'deb http://downloads-distro.mongodb.org/repo/ubuntu-upstart dist
10gen' | sudo tee /etc/apt/sources.list.d/mongodb.list

$ sudo apt-get update

$ sudo apt-get install mongodb-10gen
```

Once these steps are completed, MongoDB should be installed and ready to run on your system. Execute the following command in a terminal to be sure:

```
$ mongod
Sun Mar 16 12:04:20 [initandlisten] waiting for connections on port 27017
```

Success! Your MongoDB server is up and running. You can type in `Ctrl-C` to cancel and shut down the server.

It's important to note that you are performing local development on your development machine and not a production server, you don't need the MongoDB server to be always up and running. This would be unnecessary strain on your machine during the majority of the time you're not developing against the server. Because of this, throughout the remainder of this book, it will always be a required that you manually launch the server every time you launch code that expects to connect to a MongoDB server. If you want, you can certainly configure MongoDB to run locally as a service and be "always up" but instructions to do so are beyond the scope of this chapter.

Confirming successful MongoDB installation

Now that MongoDB has been installed on your system, let's run a quick test to ensure everything is working properly.

Access the command line via your terminal program and execute the following command:

```
$ mongod --version
db version v2.4.8
Sun Mar 16 14:17:18.280 git version: a123b456c789d012e345f678
$ mongo --version
MongoDB shell version 2.4.8
```

Assuming your MongoDB installation was successful, you should see the version number that was installed in the output on the screen right below the command you executed.

Note that your version numbers will most likely be more recent than those printed in the preceding example.

Bookmarking the online documentation

Be sure to point your browser to the following online documentation for MongoDB and bookmark it, as it will undoubtedly become a resource that you will want to access on a regular basis:

`http://docs.mongodb.org/manual/`.

Writing your first app

Now that you have everything installed and confirmed that it's all working, you can write your first quick app that will use both Node and MongoDB. This will prove that your environment is good to go, and you're ready to get started. In addition, it will give you a brief taste of the world of Node and MongoDB development! Don't worry if a lot of the following is confusing or just doesn't make sense to you—it will all be made clear throughout the rest of the book!

Step one is to create a folder that you can work from while creating files and installing Node modules. From your home or development folder, execute the following commands:

```
$ mkdir testapp
$ cd testapp
```

The code

The first thing you need to do before you write any code is download any modules you plan to use with your app from npm. Since this is a basic app, you'll only need to use the MongoDB Node driver. You can easily install this by executing the following command:

```
(term_1)$ npm install mongodb
```

After npm installs the MongoDB driver, you can list the contents of the directory, and you'll see that a new folder named `node_modules` was created. This is where, surprisingly enough, all node modules are stored whenever you install them from npm. Inside the `node_modules` folder should be a single folder named `mongodb`.

For the purposes of this demo, it's going to be a little easier if you have three separate terminal windows open. I've labeled each with `(term_N)` to make things a little more clear as we go.

Now let's write a simple app to test things out. This app is going to basically connect to our locally running MongoDB server, insert a few records as seed data, and then output those same records to the screen. The code should give you some insight into the use of callbacks and the potential pitfall of Node's async nature.

You can download a gist of the following code at `http://bit.ly/1nvTVcM`.

Using your editor of choice, create a new file named `app.js`, save it to the same location you executed `npm install`, and insert the following complete set of code:

```
var MongoClient = require('mongodb').MongoClient;
```

First, we `require` the MongoDB Node driver that you installed via npm. `require` is a Node.js convention to bring in external dependencies—similar to `using` or `import` in other languages:

```
var dbhost = 'mongodb://localhost:27017/test',
    myCollection = 'chapter2';
```

Next we declare a `dbhost` variable for the database server information and collection (table) you want to work with. Here, `test` is the database you want to use and `chapter2` is the collection. In MongoDB, if you reference and try to use a collection that doesn't exist, it will automatically be created.

The `seedData` function will first check to see whether we already have any records in our collection or not. If the collection is empty, a few sample records will be inserted. Note that the parameters for this function are the database and a callback function. The callback function will be called once the work is finished:

```
var seedData = function(db, callback) {
    db.collection(myCollection).find({}, {}, {})
        .toArray(
            function(err, docs) {
                if (docs.length <= 0) {
                    console.log('No data. Seeding...');

                    // count each record as its inserted
                    var ihandler = function(err, recs) {
                        if (err) throw err;
                        inserted++;
                    }

                    var toinsert = 2,
                        inserted = 0;
```

```
                    // perform a MongoDB insert for each record
                    db.collection(myCollection).insert({
                        'Title': 'Snow Crash',
                        'Author': 'Neal Stephenson'
                    }, ihandler);
                    db.collection(myCollection).insert({
                        'Title': 'Neuromancer',
                        'Author': 'William Gibson'
                    }, ihandler);

                    // wait for the 2 records above to be finished
                   // inserting
                    var sync = setInterval(function(){
                        if(inserted === toinsert) {
                            clearInterval(sync);
                            callback(db);
                        }
                    }, 50);
                    return;
                }
                callback(db);
                return;
            }
        );
}
```

Take note of the use of `setInterval`. This is used because Node by its very nature is asynchronous, which means it will execute all of the code line by line and won't stop and wait for anything to finish. Since our callback might get called before we finish inserting our records (inserts to the MongoDB server might take longer than our lines of code can execute). We will implement a simple count mechanism that will count the number of records inserted and compare it to the number of records expected to be inserted. This will occur in a loop every 50 milliseconds. Once the fifth and final record has been inserted, our callback will then be called with the database object passed into it as a parameter.

Using `setInterval` like this is actually a bad practice. Normally, we would rely on a third-party module or framework to handle a situation like this to prevent the need for intervals as well as improve readability. I only included it for the sake of brevity.

The `showDocs` function will basically connect to the database using the same collection name we defined earlier, and loop through every record returned and output the information to the screen using a basic `console.log()`:

```
var showDocs = function(db) {
    console.log("Listing books:");
    var options = {
        sort: [['Title',1]]
    };

    // find and return an array of all records in the collection
    db.collection(myCollection).find({}, {}, options)
        .toArray(
            function(err, docs) {
                if (err) throw err;

                // for each item in the collection, print the title
and author
                for(var d = 0; d < docs.length; d++) {
                    console.log(docs[d].Title + '; ' + docs[d].
Author);
                }

                db.close();
            }
    );
}
```

Finally, we will use the actual `MongoClient` that we required in the very first line of the app and use its `connect()` method. The callback that is executed once the connection is established is defined right inline using an anonymous function. This function calls `seedData` and passes it the `db` object as well as the callback we want to use; in this case, our `showDocs` function:

```
MongoClient.connect(dbhost, function(err, db){
    if (err) throw err;

    // once connected, execute the seedData function to start the app
    seedData(db, showDocs);
});
```

Ironically, even though the `MongoClient.connect()` code is declared at the bottom of the file, it's actually the first set of code to execute. In the next chapter, you will learn how to write your own modules that you can require so that the `seedData` and `showDocs` functions exist in separate files.

Launch the sample app

Once you have the complete code saved to `app.js`, it's time to execute it and see what happens. However, before you can launch an app that clearly relies on a connection to MongoDB, you need to first boot up a server:

```
(term_2)$ mongod
```

In Windows, if you haven't set a PATH variable for `mongod`, you may need to use the full path while executing MongoDB, which is `c:\mongodb\bin\mongod.exe`. For your needs, the remainder of this book will refer to the `mongod` command, but you may always need to execute the full path in each instance.

Now to launch the app itself, execute the following command:

```
(term_1)$ node app.js
```

When the app first executes, you should see the following output:

```
No data. Seeding...
Listing books:
Neuromancer; William Gibson
Snow Crash; Neal Stephenson
```

If you were to run the app again, you will see that the `No data. Seeding...` message doesn't appear. This is because our app is smart enough to check to make sure it doesn't need to insert the records every time it runs (only whenever there is no data in the collection).

Check the actual database

Let's take a quick look at the database itself to see what happened during the execution of the app. Since the server is currently up and running, we can connect to it using the mongo shell—a command line interface to the MongoDB server. Execute the following commands to connect to the server using `mongo`, and run a query against the `chapter2` collection:

```
(term_3)$ mongo
MongoDB shell version: 2.4.8
connecting to: test
```

```
> show collections
chapter2
system.indexes
> db.chapter2.find().pretty()
```

You should see something similar to the following output that lists each of the records that were inserted during the `seedData` function of the app:

```
{
    "Title" : "Snow Crash",
    "Author" : "Neal Stephenson",
    "_id" : ObjectId("5326268a4937f98403fca895")
}
{
    "Title" : "Neuromancer",
    "Author" : "William Gibson",
    "_id" : ObjectId("5326268a4937f98403fca896")
}
```

Note that the use of `.pretty()` is simply a mongo shell command that properly formats the output of any queries you execute. Without it, the preceding output would have been displayed as a single line and would have been fairly unreadable.

Summary

In this chapter, we took time to make sure your development environment was properly configured with both the Node runtime environment as well as the MongoDB server. After making sure both were properly installed, we wrote a basic app that utilized both technologies.

The app connected to a locally running MongoDB server, checked for the existence of a specific set of data, and if it wasn't found, sample records were inserted automatically. It then retrieved those same records and displayed them to the screen, which were sorted alphabetically.

Now that the tedious but necessary tasks of set up and installation are out of the way, we can move on to some fun and get started with learning! In the next chapter, we will review a primer on the JavaScript language and understand the basics of Node. Then, we will review basic **Create, Read, Update, Delete** (**CRUD**) operations with MongoDB using the mongo shell.

3
Node and MongoDB Basics

Before we dig in and start building a full-blown web application using Node and MongoDB, it's important that we review some of the basics first. This chapter will give you a crash course on the syntax and important topics. It is broken down into two parts where the first half focuses on JavaScript or Node and the second half covers MongoDB. You will gain insight into some of the more common and powerful tools available to you, and we will review a lot of sample code to get you up to speed.

In this chapter, we will review the following topics:

- Fundamentals of the JavaScript language
- The basics of NodeJS
- Node's Package Manager, npm
- The basics of MongoDB

By the end of this chapter, you should have a solid understanding of the syntax and how to use both Node and MongoDB. There's a lot to cover, so let's get started.

A JavaScript Primer

Node.js is just JavaScript on the server. The language syntax and tools you are used to with coding JavaScript on the browser will work verbatim on the server. Node.js has additional tools that are only available on the server, but the language and syntax again are the same. I'm assuming you have a general understanding of the basic JavaScript syntax, but I will introduce JavaScript to you with a very brief primer on the language just in case.

In general, JavaScript is a fairly simple language when it comes to syntax, and you only need to know a few important elements.

Declaring variables

The most basic thing you can do in pretty much any programming language is declare a variable. Unlike most other languages, JavaScript is a dynamically typed language, which means when you declare a variable, its value can be of any type and can change during the course of its lifetime. However, in contrast, a strongly typed language dictates that a variable defined as a type of string must always be a string and must always have a value of a string.

To declare a variable in JavaScript, simply use the `var` keyword before your variable name:

```
var myVariable;    // declaring a variable with no value

var myOtherVariable = 'Hello!';
var myFirstName = "Jason";
var myLastName = "Krol";
//note that strings can use ' or " interchangeably
var myFullName = myFirstName + ' ' + myLastName;
// => Jason Krol
// addition with strings will concatenate

var someNumber = 1,
    anotherNumber = 25;
/* note that you can declare multiple variables separated with commas
*/
var total = someNumber + anotherNumber;  // => 26
// addition with numbers will perform Math
whatIfIForgetVar = "uh oh";
```

As you can see in the preceding code snippet, there are a number of options available when declaring variables. JavaScript is pretty forgiving for the most part, as you can use single and double quotes interchangeably (although not recommended) as long as they match. You can declare every variable using a `var` keyword per line, or you can separate a list of multiple variables with a comma using a single `var`. While not mandatory, it's expected that every line of code in JavaScript ends with a semicolon (`;`). Without a semicolon, the code will still work, but it may produce unwanted results.

A quick gotcha is in there with the `whatIfIForgetVar` variable. Without the `var` keyword, the variable is still defined, however its scope is set globally. This is bad as it can clash with another globally scoped variable of the same name! JavaScript follows function-level scoping, which is somewhat different from other languages.

Always define your variables using the `var` keyword, and pay attention to the function that variables are being defined in. With the preceding sample code, we actually never defined a function and just started writing code. This means that without a base function to execute in, the code itself will actually belong to the global window object. Generally, it is considered a bad practice to ever write code directly against a global scope like this.

Declaring functions

Using the same `var` keyword, you can define functions in the same way as variables. The only difference is that you use the function signature to define your function:

```
function sayHello() {
    console.log('Hello!');
}
// or
var sayHello = function() {
  console.log('Hello!');
}
```

Both methods are almost identical in the preceding sample code. The first method is the most common way to define a function; however, you can use the `var` keyword if you want to treat your function like a variable (that is, pass it as a parameter to another function and so on).

You will then call your named function by simply using the function (or variable) name, followed by open and close parentheses:

```
sayHello();
```

This function will simply log the `Hello!` string. Functions can accept any number of parameters and can return any value (or not). Functions can be called from within other functions. Functions can also be passed as parameters to other functions:

```
var doWork = function(val) {
  var half = val / 2;
  // do more work...
}
var someValue = 20;
doWork(someValue);

var fullName = function(firstName, lastName) {
    return firstName + ' ' + lastName;
}
```

```
console.log(fullName('Jason', 'Krol'));
// => Jason Krol

var getFirstName = function() {
  return 'Jason';
}
var getLastName = function() {
  return 'Krol';
}

// accepting functions as parameters to be called later:
function findFullName(firstName, lastName) {
   var fname = firstName();
    var lname = lastName();
    console.log(fname + ' ' + lname);
}
findFullName(getFirstName, getLastName);
// => Jason Krol
```

Declaring objects

Creating an empty object in JavaScript is one of the easiest things you can do:

```
var myObject = {};    // that's it!
```

By simply using the open and close braces, `{ }`, you have created a brand new object. Using this new object, you can assign any properties or methods you want:

```
var person = {};
person.firstName = 'Jason';    // properties
person.lastName = 'Krol';

person.fullName = function() {  // methods
  return this.firstName + ' ' + this.lastName;
}
person.colors = ['red', 'blue', 'green'];  // array property
```

You can see in the preceding code that we defined a basic object called `person` and assigned it some properties and a function. It's important to note the use of the `this` keyword in the `fullName` function. The `this` keyword refers to the object that the function is assigned to.

```
// define properties during declaration
var book = {
  title: 'Web Development with MongoDB and NodeJS',
```

```
  author: 'Jason Krol',
  publisher: 'Packt Publishing'
};
console.log(book.title);
// => Web Development with MongoDB and NodeJS
book.pageCount = 150;    // add new properties
```

Here, we instantiated a new object called `book` but defined some properties at the same time. We added another property a little later.

Objects can be nested with infinite possibilities, as shown in the following code:

```
var jason = {
  name: 'Jason Krol'
};
var book = {
  title: 'Web Development with MongoDB and NodeJS',
  publisher: 'Packt Publishing',
  author: jason
};
console.log(book.author.name);
// => Jason Krol
```

Functions are objects

In JavaScript, functions are considered first-class citizens. What this means is that a function by itself *is* an object, so it can be treated as such and extended with properties and additional functions. Here, we will take a standard function (in this case, `myFunction`). We will assign this function a property (`timesRun`), just like we would for any other object during its execution, and show how you can refer to that property later:

```
var myFunction = function() {
  if(this.timesRun)
    this.timesRun += 1;
  else
    this.timesRun = 1;


  // do some actual work

  console.log(this.timesRun);
}
```

```
myFunction();
// => 1;
myFunction();
// => 2;
myFunction();
// => 3;

console.log(myFunction.timesRun);
// => undefined
```

Note the last line where we tried to log the `timesRun` property of `myFunction` but received `undefined` in the output. This is because the property is privately scoped to the function so it is only visible from within the function (that is, only visible to the code executing inside the function).

Anonymous functions and callbacks

Often, you will need to use a temporary function that you don't necessarily want to declare ahead of time. In this type of a scenario, you can use an anonymous function, which is simply a function that is declared at the time you need it (this function isn't assigned to a variable, so it has no way of being referenced to later). The most common use of anonymous functions is when they are defined as a parameter to another function (most notably when used as a *callback*).

One of the most common places to use an anonymous function (which also acts as a callback even if you didn't realize it) is with `setTimeout` or `setInterval`. These are two standard JavaScript functions that will execute code after a specified delay (in milliseconds) or repeat the execution of code every specified delay. Here is an example of one of them, `setTimeout`, using an anonymous inline function:

```
console.log('Hello...');
setTimeout(function() {
  console.log('World!');
}, 5000);
// => Hello...
// (5000 milliseconds i.e. 5 second delay)
// => World!
```

You can see that the anonymous function was passed as the first parameter to `setTimeout` because `setTimeout` expects a function. You can, if you so desire, declare the function ahead of time as a variable and pass that to `setTimeout` instead of the inline anonymous function:

```
var sayWorld = function() {
  console.log('World!');
```

```
}
setTimeout(sayWorld, 5000);
// (5 second delay)
// => World!
```

The anonymous function just acts as a clean inline disposable function.

Callbacks are important because one of the most powerful (and confusing) features of JavaScript is that it's asynchronous. This means that every line executes sequentially, but it doesn't wait around for code that might be taking longer than it should (even if by design). Consider the following idea: you want to call two functions sequentially; however, the first function may take a while (maybe it makes a network call, or performs a long loop). What happens if the second function is executed before the first is finished? The answer lies in the following code:

```
var someValue;
var myFunction = function(){
  // change someValue eafter 5 seconds
  setTimeout(function() {
    someValue = someValue / 2;
  }, 5000);
}

someValue = 100;
myFunction();
console.log(someValue);
// => 100
```

When your code executes `myFunction`, it will actually wait 5 seconds before it divides the `someValue` variable in half. However, `console.log` on the following line of the function call will execute immediately after. This is contrary to our desired effect, which is to have the `console.log` show the value of `someValue` after the work on it has been performed via `myFunction`. The solution to this is to use a callback. An anonymous function will be passed to `myFunction` and will only be executed once `myFunction` has actually finished execution:

```
var someValue;
var myFunction = function(callback){
  // change someValue after 5 seconds
  setTimeout(function() {
    someValue = someValue / 2;
    callback(someValue);
  }, 5000);
}
```

```
someValue = 100;
myFunction(function() {
  console.log(someValue);
});
// => 50
```

Arrays

Arrays work the same way in JavaScript as they do in pretty much any other language. They are zero indexed, and you can declare a variable as an empty array or prepopulated array. You can manipulate the items in an array, and arrays are not fixed in length:

```
var favFoods = ['pizza', 'cheeseburgers', 'french fries'];

var stuff = [];        // empty array
var moreStuff = new Array();       // empty array
var firstFood = favFoods[0];    // => pizza

// array functions:
favFoods.push('salad');    // add new item
// => ['pizza', 'cheeseburgers', 'french fries', 'salad']
favFoods.pop();        // remove the last item
// => ['pizza', 'cheeseburgers', 'french fries']
var first = favFoods.shift();     // remove the first item
// => first = 'pizza';
// => favFoods = ['cheeseburgers', 'french fries']
```

Conditions and comparison operators

The most common condition statement you will write in JavaScript is the `if` statement. All block-level code that follows an `if` statement should be wrapped in { and }. This rule extends to pretty much all code structures in JavaScript. In an `if` statement, any value greater or less than zero, not null, and not undefined equates to "truthy". 0, null, undefined, or an empty string equates to "falsey".

There are a number of comparison operators available, and understanding the difference among these will matter when it comes to a random bug that you spend way too much time trying to figure out because you had `==` instead of `===`:

```
var x = 5;
==  equal to      x == 5 true, x == '5' true, x == 8 false
=== exactly equal    x === 5 true, x === '5' false
```

```
!=   not equal to      x != 6 true, x != '5' false
!==   not equal to exactly

>, <, >=, <=      greater than, less than, greater than or equal
to, less than or equal to
```

The main difference to understand is that `==` and `!=` are type indifferent. So, an integer of `5` is equal to a string of `'5'`. However, `===` and `!===` are type specific. So, a string of `'5'` is *not* equal to an integer of `5` (when compared using `===`):

```
if(1 === 1)
  doWork();

var myVar = 1;
if(myVar > 0)
{
  myVar = myVar * 2;
  doWork(myVar);
} else
  doWork(0);

if (myVar === 0) {
  doWork();
} else if (myVar > 0 && myVar < 10) {  // && is AND
  var val = doNothing();
  if (val || myVar === 5) {      // || is OR
    lastMinuteCleanup();
  }
} else {
  var errorcode = abort();
  if (!errorcode) {        // ! is NOT
    console.log('There was an error!');
  }
}
```

Flow

The basic control of flow within JavaScript is going to be handled by `if` statements and any number of looping control flow statements available. A basic example of `for` loop is as follows:

```
var myVar = 0;
for(var i = 0; i < 100; i += 1) {
  myVar = i;
```

```
  console.log(myVar);
}
// => 1 2 3 4 5 6 7 8 ... 100
```

Additional loops are available in JavaScript as follows:

```
var x = 0;
do {
  x += 1;
  console.log(x);
} while (x < 100);
// => 1 2 3 4 5 6 7 8 ... 100

while (x > 90) {
  x -= 1;
  console.log(x);
}
// => 99 98 97 96 95 94 93 92 91 90
```

JSON

JSON, or JavaScript Object Notation, is the standard syntax used when dealing with data in JavaScript as well as most other languages and web services. The basic premise of JSON is that it looks exactly like a standard JavaScript object with a few strict exceptions:

- JSON is pure text. There are no datatypes with properties; that is, date values are stored as strings and so on.
- All names and string values must be in double quotes.
- There can be no functions as properties.

Let's take a quick look at a pretty standard JSON object:

```
{
  title: 'This is the title',
  description: 'Here is where the description would be',
  'page-count': 150,
  authors: [
    { name: 'John Smith' },
    { name: 'Jane Doe' },
    { name: 'Andrea Johnson' }
  ],
  id: '1234-567-89012345'
}
```

If you are familiar at all with XML, JSON is somewhat similar, except it is much easier to read and make sense out of. As described best by the ECMA, *JSON is a text format that facilitates structured data interchange between all programming languages*.

The basics of NodeJS

With the basics of JavaScript out of the way, let's focus on some of the basics of Node.

Event driven

At its core, one of the most powerful features of Node is that it is event driven. This means that almost all code you write in Node is going to be written in a way that is either responding to an event or is itself firing an event (which in turn will fire off other code listening for that event).

Let's take a look at code that we'll write in a later chapter that handles connecting to a MongoDB server using Mongoose, a popular Node.js MongoDB ODM module:

```
mongoose.connect('mongodb://localhost/MyApp');
mongoose.connection.on('open', function() {
console.log("Connected to Mongoose...");
});
```

First, we tell our `mongoose` object to connect to the server provided as a string parameter to the function. Connecting will take an undetermined amount of time though, and we have no way of knowing how long. So, what we do is bind a listener to the `'open'` event on the `mongoose.connection` object. With the use of the `on` keyword, we are indicating that when the `mongoose.connection` object triggers an `'open'` event, it executes the anonymous function that was passed in as the parameter.

Asynchronous

Earlier, we reviewed the idea of asynchronous JavaScript code in the browser using `setTimeout`—the principles apply even more in the world of Node. As you might be making a number of network-dependent connections to different REST API services, database servers, and anything else, it's important that your code can execute smoothly and has proper callback usage in place whenever each service responds.

Require and modules

In an effort to make code as modular and reusable as possible, Node uses a module system that allows you to better organize your code. The basic premise is that you write code fulfilling a single concern and export this code as a module that serves that single purpose. Then, whenever you need to use that code elsewhere in your code base, you would require that module:

```
// ** file: dowork.js
module.exports = {
  doWork: function(param1, param2) {
    return param1 + param2;
  }
}

// ** file: testing.js
var worker = require('./dowork'); // note: no .js in the file

var something = 1;
var somethingElse = 2;

var newVal = worker.doWork(something, somethingElse);
console.log(newVal);
// => 3
```

Using this system, it's simple to reuse the functionality in a module (in this case, the `dowork` module) in any number of other files. Furthermore, the individual files of a module act as a private namespace. Any variables declared and used within the module file are private to that module and not exposed to any code that uses the module via `require()`.

This system extends infinitely as well. Within your modules, you can require other modules and so on and so forth.

The NodeJS core

The NodeJS core literally has hundreds of modules available for you to use while writing your applications. These include the following:

- Events
- Filesystem
- HTTP
- Net
- Streams
- Timers

Definitely make sure to check out the online docs on Node (at `http://nodejs.org/api`) to see the full list of modules available in Node's core and see plenty of sample code and explanations.

Installing modules using npm

The module system in Node is so powerful that consuming a third-party module written by other developers is a piece of cake. Node includes its own package manager called npm, which is a registry that currently contains over 60,000 unique modules written in Node. These modules are completely open source and available to you via a few short commands. In addition, you can release your own personal modules via npm and allow anyone in the world to use your feature!

Let's say you wanted to include the popular web framework Express in your project (the one we will be using later in this book). There are simply two steps required to download a module and use it in your code:

```
$ npm install express
// ** file: usingnpm.js
var express = require('express);
```

And that's it! Literally, it's that simple! From the command line of the folder where your project is located, simply execute `npm install package-name`, and the package will be downloaded from npm and stored in a folder called `node_modules` within your project. If you browsed to the `node_modules` folder, you will find a folder for the package you installed, and within that folder, you will find the raw source code for the package itself. Once the package is downloaded, it's as simple as using `require()` from within your code.

There may be times when you want to install a Node package globally, for example, when using a popular command-line build tool called Grunt.js. To install an npm package globally, simply include the `-g` or `--global` flag, and the module will be installed as a global executable instead. When installing npm packages globally, the source files for the package are not stored within the `node_modules` folder of a specific project, but instead within a `node_modules` folder in a system directory of your machine.

A really powerful feature of npm is that it allows for a quick, easy, and consistent way for other developers to boot up your code in their local environment. Node projects typically include a special file called `package.json` that includes information about the project as well as a list of all npm packages that the project depends on. A developer with a copy of your local code can simply execute `npm install` to have every dependency downloaded and installed locally using this file.

The npm install flag `--save` or `--save-dev` is required if you want the dependency you are installing to be saved to the `package.json` file. If you are starting a new project and don't want to create a `package.json` file by hand, you can simply execute `npm init` and answer a few quick questions to get a default `package.json` file quickly set up. You can leave every question blank during `init` and accept the default values if you want:

```
$ npm init

$ npm install express --save
$ npm install grunt --save-dev
$ cat package.json
{
 "name": "chapter3",
 "version": "0.0.0",
 "description": "",
 "main": "index.js",
 "scripts": {
   "test": "echo \"Error: no test specified\" && exit 1"
 },
 "author": "",
 "license": "ISC",
 "dependencies": {
   "express": "^3.5.1"
 },
 "devDependencies": {
   "grunt": "^0.4.4"
 }
}
```

Note that the `dependencies` and `devDependencies` sections have `express` and `grunt` listed. The difference between these two sections is that the `dependencies` section is absolutely critical for the app to function properly. The `devDependencies` section has only packages that need to be installed for a developer to use during the development of the project (such as Grunt for various build steps, testing frameworks, and so on).

The basics of MongoDB

Since MongoDB is largely powered by JavaScript, the mongo shell acts as a JavaScript environment. In addition to being able to execute regular Mongo queries, you can also execute standard JavaScript statements. Most of the items mentioned earlier in the JavaScript primer apply directly to the mongo shell as well.

In this next section, we will focus primarily on the various ways to perform standard **create, read, update, delete** (**CRUD**) operations via the mongo shell.

The mongo shell

To access the mongo shell, simply execute `mongo` from any terminal. The mongo shell requires the `mongod` server to be currently running and available on the machine as the first thing it does is connect to the server:

```
$ mongo
MongoDB shell version: 2.4.5
connecting to: test
>
```

By default, when you first launch Mongo, you are connected to the local server and set to use the `test` database. To display a list of all databases on the server, use the following command:

```
> show dbs
```

To switch databases to any of those listed in the output of `show dbs`, use the following command:

```
> use chapter3
switched to db chapter3
```

An interesting thing to make note of is that if you use `use` on a database that doesn't exist, one is instantly created automatically. If you are using an existing database and want to view a list of collections in the database, execute the following command:

```
> show collections
```

In the case of my `chapter3` database, I had no existing collections since it was automatically generated as a new database for me.

Inserting data

Since we are working with the `chapter3` database that is brand new, there are currently no collections in the database. You can use any collection (table) you want by simply referring to a new collection name with the `db` object:

```
> db.newCollection.find()
>
```

Performing a `find` operation on an empty collection simply returns nothing. Let's insert some data so we can experiment with some queries:

```
> db.newCollection.insert({ name: 'Jason Krol', website: 'http://
kroltech.com' })
> db.newCollection.find().pretty()
{
  "_id" : ObjectId("5338b749dc8738babbb5a45a"),
  "name" : "Jason Krol",
  "website" : "http://kroltech.com"
}
```

After we perform a simple insertion (of basically a JavaScript JSON object), we perform another find operation on the collection and get our new record returned this time with an additional `_id` field added. The `_id` field is Mongo's method of tracking a unique identifier for every document (record). We also chained the `pretty()` function to the end of the find that outputs the results a little more nicely.

Go ahead and insert a few more records so you have some data to play with in the next section when we go over querying.

Querying

Querying and searching for documents in a MongoDB collection is pretty straightforward. Using the `find()` function by itself with no parameters will return every document in the collection. To narrow down the search results, you can provide a JSON object as the first parameter with as much or as little specific information to match against, as shown in the following code:

```
> db.newCollection.find({ name: 'Jason Krol' })
{ "_id" : ObjectId("533dfb9433519b9339d3d9e1"), "name" : "Jason Krol",
"website" : "http://kroltech.com" }
```

You can include additional parameters to make the search more precise:

```
> db.newCollection.find({ name: 'Jason Krol', website: 'http://kroltech.
com'})
{ "_id" : ObjectId("533dfb9433519b9339d3d9e1"), "name" : "Jason Krol",
"website" : "http://kroltech.com" }
```

Note that with each result set, every field is included. If you want to only return a specific set of fields with the result, you can include a map as the second parameter to `find()`:

```
> db.newCollection.find({ name: 'Jason Krol' }, { name: true })
{ "_id" : ObjectId("533dfb9433519b9339d3d9e1"), "name" : "Jason Krol" }
```

```
> db.newCollection.find({ name: 'Jason Krol' }, { name: true, _id: false
})
{ "name" : "Jason Krol" }
```

Note that the `_id` field will always be included by default unless you specifically state that you don't want it included.

Additionally, you can use query operators to search for things that are within ranges. These include greater than (or equal to) and less than (or equal to). If you wanted to perform a search against a collection of homework, and you wanted to find every document with a score within the B range (80-89), you can execute the following search:

```
> db.homework_scores.find({ score: { $gte: 80, $lt: 90 } })
```

Finally, you can use `regex` while performing a search to return multiple matching documents:

```
> db.newCollection.find({ name: { $regex: 'Krol'} })
```

The preceding query will return every document that contains the word `Krol`. You can get as advanced as you want with the `regex` statements.

If you knew that you were going to be returning multiple documents on a query and only wanted the first result, use `findOne()` in place of a regular `find()` operation.

Updating data

To update a record, use the `update()` function but include a `find` query as the first parameter:

```
> db.newCollection.update({ name: 'Jason Krol' }, { website: 'http://
jasonkrol.com' })
```

There's a bit of a catch here. If you perform a new `find({ name: 'Jason Krol' })` operation, something strange happens. No data is returned. What happened? Well, the second parameter in the `update()` function is actually the new version of the complete document. Since we only wanted to update the `website` field, what actually happened was that the document that was found was replaced with the new version that consists of only the `website` field. To reiterate, the reason this happens at all is because with NoSQL such as MongoDB, the document does not have a set number of fields (like a relational database does). To fix this problem, you should use the `$set` operator instead:

```
> db.newCollection.update({ name: 'Jason Krol' }, { $set: { website:
'http://jasonkrol.com'} })
```

There may be a time when you want to update a document, but the document itself may or may not exist. What happens when the document does not exist, and you'd like for a new one to be created instantly based on the updated values you provide? Well, there's a handy function just for that. Pass `{upsert: true}` as the third parameter to the `update()` function:

```
> db.newCollection.update({ name: 'Joe Smith' }, { name: 'Joe Smith',
website: 'http://google.com' }, { upsert: true })
```

If we have a document with a name field that matches `'Joe Smith'`, the website field will be updated (and the `name` field preserved). However, if we do not have a matching document, a new one will be created automatically.

Deleting data

Deleting documents works almost exactly like `find()` except instead of finding and returning results, it deletes those documents that match the search criteria:

```
> db.newCollection.remove({ name: 'Jason Krol' })
```

If you want the nuclear option, you can use the `drop()` function that will remove every document in a collection:

```
> db.newCollection.drop()
```

Additional resources

For additional learning with JavaScript, I suggest you check out some of the following resources:

- Mozilla Developer Network at `https://developer.mozilla.org/en-US/docs/Web/JavaScript`
- *Secrets of the JavaScript Ninja*, *John Resig*, *Bear Bibeault*, *Manning*
- *Learning JavaScript Design Patterns*, *Addy Osmani*, *O'Reilly*
- *JavaScript: The Good Parts*, *Douglas Crockford*, *O'Reilly*

The Node API online documentation is going to be your best bet to fully understanding everything that's available within the Node core set of modules. The Node API docs can be found at `http://nodejs.org/api`.

Additionally, there is a great website that teaches Node using actual programming problems that you must solve. The emphasis with these exercises is to understand the nuts and bolts of how Node works and get down into the fundamentals of working with streams, asynchronous I/O, promises, and more. Node School can be found at `http://nodeschool.io`.

Finally, the creators of MongoDB offer an amazing 7-8 week online training and certification programs completely free of charge, where you will learn everything you need to be a true MongoDB master. This can be found at MongoDB University at `https://university.mongodb.com`.

Now it's time to dive in and start writing some real code!

Summary

In this chapter, you took a crash course on the basics of JavaScript, Node.js, and MongoDB. In addition, you learned about Node's Package Manager, npm. For further learning, additional resources were provided for JavaScript, Node.js as well as MongoDB.

In the next chapter, you will write your first Node web server using Express.js and get started with creating a complete web application.

4

Writing an Express.js Server

Plain old vanilla Node by itself is not a very good solution for creating web applications. You will have to write a heck of a lot of boilerplate code just to get off the ground. All of the pieces are there, but why go through all that trouble when somebody has already done it for us!

In this chapter:

- I will introduce you to the Express.js web application framework
- We will write the basic Node.js code necessary to bootstrap a server
- We will also take a look at what's necessary to migrate to Express.js v4

What is Express.js?

As described perfectly on its home page, Express is a *minimal and flexible Node.js web application framework, providing a robust set of features for building single and multi-page, and hybrid web applications*. In other words, it provides all of the tools and basic building blocks you need to get a web server up and running by writing very little code. It puts the power to focus on writing your app and not worry about the nuts and bolts that go into making the basic stuff work in your hands.

The Express framework is one of the most popular Node-based web frameworks as well as one of the single most popular packages available in npm.

If you look at a sample piece of code, one of the most basic implementations of Express, you can see how easy it is to get a web server up and running, for example:

```
var express = require('express');
var app = express();
app.get('/', function(req, res){
   res.send('Hello World');
});
app.listen(3300);
```

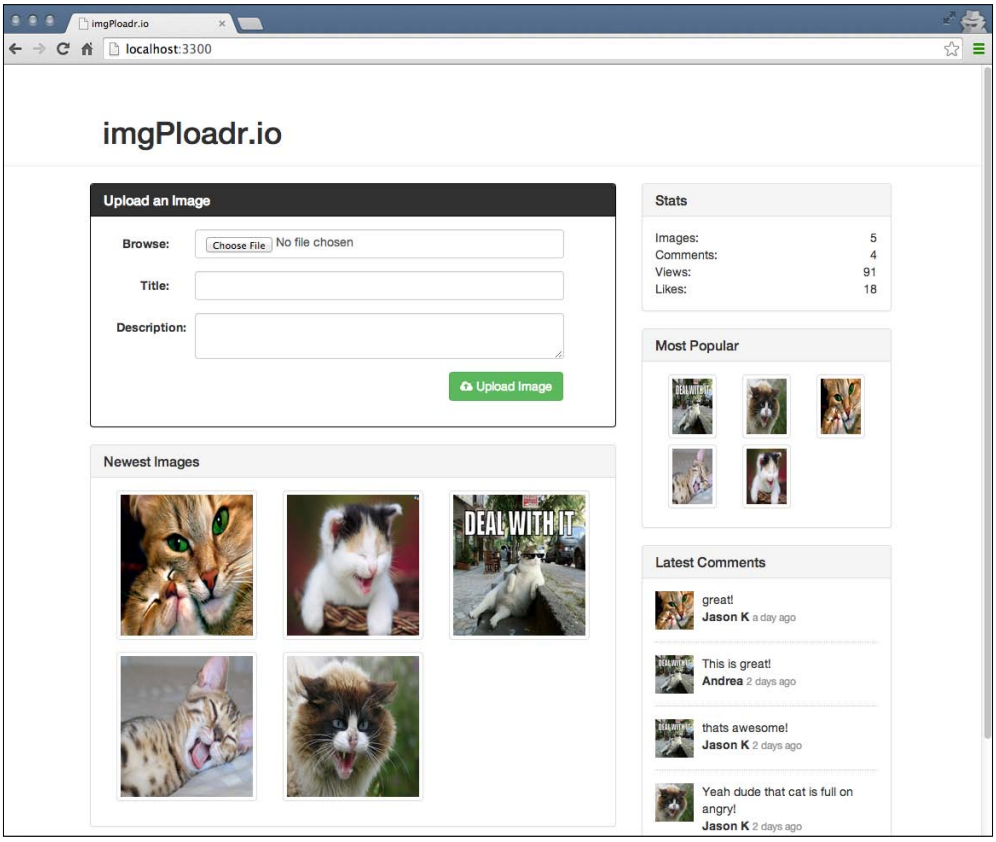
The beauty of Express is that it makes building and maintaining the server code for a website simple.

At the time of writing this book, Express is at Version 3.5.1; however, the 4.0.0 release candidate has just been released. 4.0.0 is available to experiment with but is generally considered not ready for production. This chapter will focus on working with Express 3.5.1. However, at the end of this chapter, I will go into the additional details on how to migrate the application to Version 4.0.0 as there are a few significant changes that will need to be taken into account.

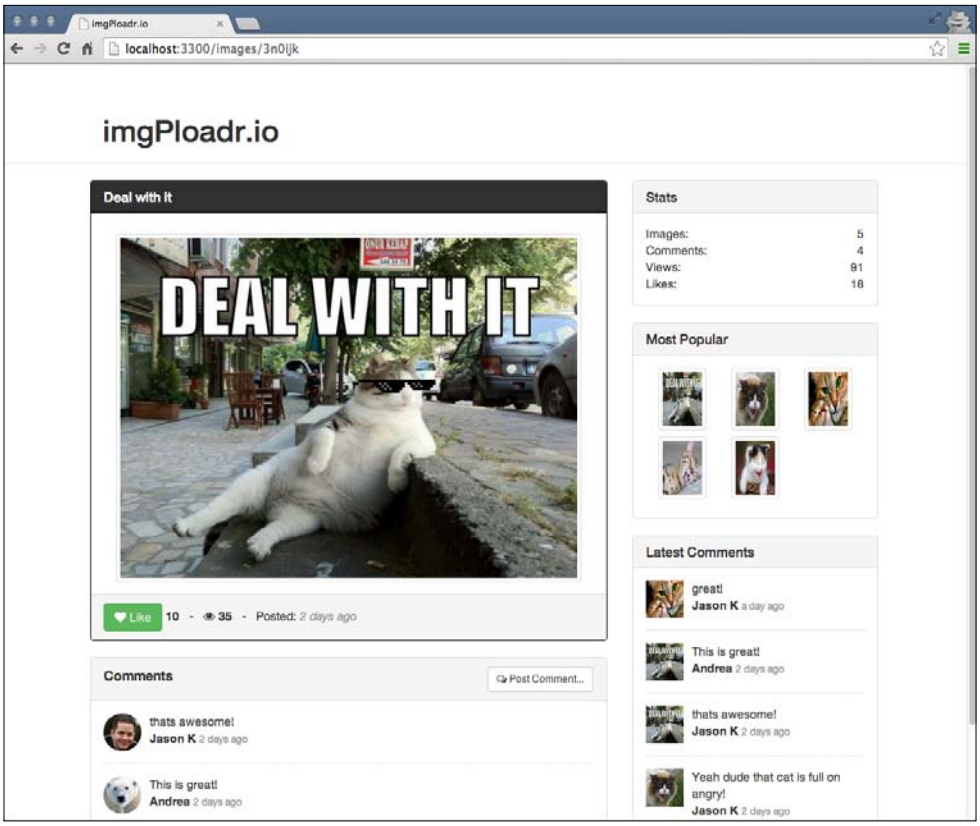
Building a complete web application

Beginning with this chapter, we are going to build a complete web application. The web application that we build will be a clone of a popular social image-sharing site. We'll call our site **imgPloadr.io**.

The following screenshot is from the home page of the completed site:



The next screenshot is an image's details page from the site:



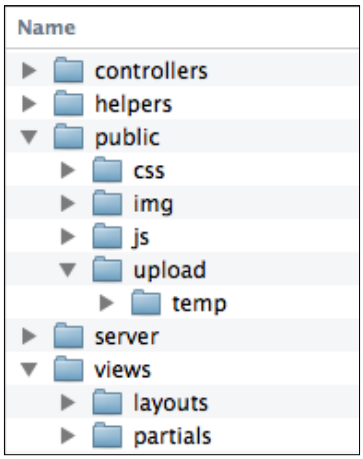
The requirements of the site are as follows:

- The home page will allow visitors to upload an image as well as browse the existing uploads, which will be ordered based on newest to oldest.
- Each uploaded image will be presented via its own page that shows its title, description, and a large image display. Visitors will be able to *like* the image as well as post comments.
- A consistent shared sidebar will be visible on both pages that will showcase some general statistics about the site, the most popular images, and most recent comments.
- The site will use Bootstrap so that it has a nice professional design and is responsive on any device.

By the end of this book, you will have written the previously mentioned fully functional application, and it will be available online!

Organizing the files

Before you get started writing any code, we want to make sure that you have a project folder set up correctly with the proper folder structure to house all of the various files that you will be creating. Get started by creating a new folder for your project, and name it anything you like. Then, inside that folder, create additional folders to match the following structure:



Each of these folders will contain important modules that we will write throughout the remainder of this chapter and book.

You are going to need a `package.json` file for this project, and the easiest way to create one of these is by simply executing the following command from the root of the project folder:

```
$ npm init
```

Respond to each of the questions as you are prompted, or simply press *Enter* repeatedly to accept the default values. Now let's install Express via npm:

```
$ npm install express@3.5 --save
```

This will install the Express framework in the `node_modules` folder and also add Express to the `package.json` file in the `dependencies` section. Note that I forced the version to 3.5.x by including the `@` character after `express`. Since 4.0.0 is available, it would have installed by default, but for our purposes, we want to work with 3.5.x.

When installing modules using npm, the latest version of the module will always be installed by default. Typically, this is fine, but there are times when the newest version might not be compatible with other modules you are using, or it's just too new to be considered ready for production. At the time of writing this book, Express is in the latter category. Version 4 is available, but it is considered not ready for production. Therefore, we need to force our version to 3.5.x.

Server.js – where it all begins

Whenever you write a Node app, you always need to start somewhere. The typical convention while building servers with Node is that you have a single `server.js` file located within the root of your project. This file will boot up the server and start the whole process. In our case, this is the file that will create the HTTP server and listen for all HTTP events, which is ultimately the point of our entire application.

We are going to keep our `server.js` pretty lean so that its contents are very self-explanatory. Any major logic that is going to be executed within this file will actually be defered to external modules hosted within other files.

Before we can do anything within `server.js`, we need to require a few modules that we're going to work with, specifically Express:

```
var express = require('express'),
   // config = require('./server/configure'),
   app = express();
```

In the preceding code, we are assigning the Express module to the variable `express`. The `config` module is actually going to be our own module that we will write shortly, but for now, since it doesn't exist, we will leave that line commented out. Finally, we will declare a variable called `app` that is actually what the Express framework returns when it is executed. This `app` object powers our entire app, which is how it was so cleverly named.

Throughout this chapter and the remainder of the book, I may include commented out code in the samples (code that starts with `//`). This is so that following along will be easier when we use the commented lines as reference points, or we can enable those features by simply uncommenting the code.

Next up, we will set a few simple settings via the `app` object using the `app.set()` function. These settings are really just a way for us to define some app-level constants that we can use throughout the rest of our code as handy shortcuts:

```
app.set('port', process.env.PORT || 3300);
app.set('views', __dirname + '/views');
// app = config(app);
```

The first two lines of the preceding code use built-in constants in Node. The `process.env.PORT` constant is an environment setting that is set on the actual machine for the default port value to the server. If no port value is set on the machine, we will hardcode a default value of 3300 to use in its place. After that, we set the location of our views (HTML pages) to `__dirname + '/views'` or, using another Node constant, the `/views` folder from within the *current working directory*. The third line of code is referencing the `config` module, which you haven't written yet, so that line is commented out.

Last but not least, we will create an HTTP server using our `app` object and tell it to listen for connections:

```
var server = app.listen(app.get('port'), function() {
    console.log('Server up: http://localhost:' + app.get('port'));
});
```

Here we will create a variable to hold an instance of the server. The server is created by executing the `listen` function on our `app` that tells it which port to listen to (in the default case, 3300) and passing in a simple anonymous callback function that will execute once the server is up and listening by executing a simple `console.log()` message. That's it! Again, make sure to save this file with the name `server.js` within the root of the project. You're ready to run your server and see if it works.

Booting up server.js

Let's take your server for a spin and see how you're doing so far:

```
$ node server.js
Server up: http://localhost:3300
```

Perfect! At this point, your server doesn't actually do anything; it just listens on port 3300 but doesn't actually respond. Try this by pointing a browser to `http://localhost:3300`. You should receive a pretty basic message that just reads **Cannot GET /**. This is because you haven't configured any routes or any actual logic in your server to say how to handle certain requests, namely a `GET` request to the default route of `/`. Before you set up your routes, however, let's first take care of that `config` module and finish up the configuration of the server.

A note about environment variables: You can set any number of environment variables right from the command line before you run your server by executing something like the following command:

```
$ PORT=5500 node server.js
Server up: http://localhost:5500
```

You can also set environment variables in your environment settings permanently. This can be done typically by editing your `.profile` file or equivalent.

Configuration module

Since we are leaving our `server.js` file very lean, there is still a fair amount of logic that is required in configuring our server. For this, we will defer to a custom module that we'll create called `configure`. To get started, create a file named `configure.js` in the `server` folder. Let's first install the dependencies that we are going to be using inside our `configure` module by performing another `npm install`:

```
$ npm install express3-handlebars --save
```

Here we just installed Handlebars, a popular template-rendering engine for HTML pages. Now that the module is installed and ready to be used, let's start writing the `configure.js` file. First, like any of our modules, we will declare our dependencies:

```
var connect = require('connect'),
    path = require('path'),
    //routes = require('./routes'),
    exphbs = require('express3-handlebars');

module.exports = function(app) {
  // configuration code...

  return app;
};
```

In the preceding code, we declared variables for each of the modules that we will be using in our custom `configure` module. Then, we defined the actual module that will be exported by this code file, more specifically a function that accepts our `app` object as a parameter as well as returns that same object (after we make some configuration modifications to it).

You should see that we require Connect, which is actually installed by default with Express.js as its one of its core dependencies. Connect is a popular third-party middleware framework that we will learn more about later in this chapter.

Handlebars view engine

By default, Express can and will happily render static HTML documents and serve them back to the client. However, unless you're building a purely static content-driven site, which is doubtful, you're more than likely going to want to render your HTML dynamically. That is, you want to generate portions of the HTML on the fly as pages are requested, perhaps using loops, conditional statements, data-driven content, and so on. In order to render dynamic HTML pages, you need to use a rendering engine.

This is where Handlebars comes in. The rendering engine is given its name because of the syntax it uses to display data, namely double pairs of braces, `{{` and `}}`. Using Handlebars, you can have sections of your HTML pages that are determined at runtime based on data passed to it. For example:

```
<div>
    <p>Hello there {{ name }}!  Todays date is {{ timestamp }}</p>
</div>
```

The actual HTML that would wind up in a visitor's browser would be:

```
<div>
    <p>Hello there Jason!  Todays date is Sun Apr 13</p>
</div>
```

The first thing we want to take care of in our `configure` module is to register Handlebars as the default view rendering engine. In the `configure.js` file, above the `return(app);` line, you should insert the following code:

```
app.engine('handlebars', exphbs.create({
    defaultLayout: 'main',
    layoutsDir: app.get('views') + '/layouts',
    partialsDir: [app.get('views') + '/partials']
}).engine);
app.set('view engine', 'handlebars');
```

First, using the Express app object that was passed into the `configure` function, we define our rendering engine of choice by calling the `engine` function of `app`. The first parameter to the `engine` function is the file extension that the rendering engine should look for, namely `.handlebars`.

The second parameter builds the engine by calling the `exphbs` module's `create` function. This `create` function takes an `options` object as a parameter, and this options object defines a number of constants for our server. Most importantly, we will define which layout is our default layout and also where our layouts will be stored. If you recall, in `server.js`, we used `app.set` to set a `'views'` property of our app that pointed to the current working directory `+ '/views'`. This setting is used when we configure the options for our rendering engine as well. You'll notice that the `partialsDir` property uses an array (with a single item) versus a single string value for `layoutsDir`. Both of these methods are interchangeable, and I just wanted to demonstrate that you could have more than one partials directory, and it could just be an array of string values.

With that set, our server now knows that any time we try to render an HTML page that has a file extension of `.handlebars`, it will use the Handlebars engine to perform the rendering. This means that we need to be sure to use Handlebars-specific syntax in our dynamic HTML pages.

We will be learning more about Handlebars and how to write dynamic HTML pages in the next chapter.

Using `.handlebars` as a file extension was purely a personal choice. Some people prefer `.hbs`, and if you want, you can use anything you like. Just make sure that the first parameter to the `app.engine()` function and the second parameter in the `app.set('view engine')` function are identical.

Other template engines

There are a number of different template engines available for you to use. One of the more popular engines (and the default engine supported by Express) is called Jade. Personally, I prefer using Handlebars because you use regular HTML, and Handlebars is also a client-side template engine for use in single-page applications with something like Backbone.js.

To learn more about the many template engines available for use with Node, check out this list on the official Joyent GitHub wiki at `https://github.com/joyent/node/wiki/modules#templating`.

Using and understanding middleware

One of the most powerful features available with Express is the concept of Middleware. The idea behind middleware is that it acts like a stack of filters that every request to your server passes through. Since every request passes through each filter, each filter can perform a specific task against the request before it passes through to the next filter. Typically, these filters are used for tasks such as cookie parsing, form field handling, session handling, authentication, and error handling and logging. The list goes on and on and you can use hundreds of third-party modules as well as simply writing your own.

The order that the middleware is called is very important. Again, using the concept of filters, as a request passes through each filter, you want to be sure that they are performing their responsibilities in the correct order. A great example of this is implementing a cookie parser before a session handler—since sessions typically rely on cookies to maintain state with a user between requests.

Another great example of how the order of middleware is important is with error handling. If any of your middleware encounter an error, they will simply pass that error along to the next middleware in the stack. If the last middleware, regardless of what it is, doesn't gracefully handle that error, it will basically show up in your application as a stack trace (and that's bad). Having an error handler configured as one of the last middleware is like saying "if all else fails, and at any point in the previous middleware a failure occurred, deal with it gracefully."

Introducing Connect

Fortunately, there is a great middleware framework that handles most of the common requirements addressed during the middleware phase. These requests include logging, parsing of HTML form fields and JSON data, cookie and session handling, and more.

Here is a current list of available middleware in the Connect framework:

- `logger`
- `csrf`
- `compress`
- `basicAuth`
- `bodyParser`
- `json`
- `urlencoded`
- `multipart`
- `timeout`
- `cookieParser`
- `session`
- `cookieSession`
- `methodOverride`
- `responseTime`
- `staticCache`
- `static`
- `directory`
- `vhost`
- `favicon`
- `limit`
- `query`
- `errorHandler`

Express versions earlier than 4.0 include and depend on these middleware by default. However, starting with Version 4.0.0, support has been completely dropped and certain existing implementations have been removed and moved to their own modules to keep Express as lean as possible. We can safely use and assume that Connect is available when using versions of Express below 4.0. However, if you used 4.0 or higher, you would need to include middleware solutions for each component you are using.

Let's wire up each of the middleware that we are going to need and ensure that they are in the correct order. Note that we are executing our Express app's `.use()` function, which is how we indicate each middleware that we want to use. Continuing with editing the `configure.js` file, insert the following code immediately before the `return app;` line (after the section you just added for the Handlebars engine):

```
app.use(connect.logger('dev'));
app.use(connect.bodyParser({
  uploadDir:path.join(__dirname, '../public/upload/temp')
}));
app.use(connect.json());
app.use(connect.urlencoded());
app.use(connect.methodOverride());
app.use(connect.cookieParser('some-secret-value-here'));
app.use(app.router);
app.use('/public/', connect.static(path.join(__dirname, '../
public')));

if ('development' === app.get('env')) {
    app.use(connect.errorHandler());
}
```

Let's take a look at each of the Connect middleware we are using in the preceding code:

- `logger('dev')`: The logger middleware simply performs a `console.log()` output of any request that is received by the server. This is very helpful for debugging your node server.
- `bodyParser`: This helps facilitate the packing of any form fields that are submitted via an HTML form submission from a browser. Form fields that are submitted via a `POST` request will be made available via the `req.body` property.
- `json`: Similar to `bodyParser` except specifically for dealing with posted JSON data via the `req.body` property.
- `urlencoded`: Similar to `bodyParser` except specifically fields submitted via a `GET` request will be made available via the `req.query` property.
- `methodOverride`: For older browsers that don't properly support REST HTTP verbs such as `UPDATE` and `PUT`, the `methodOverride` middleware allows this to be faked using a special hidden input field.

- `cookieParser`: This allows cookies to be sent/received.
- `errorHandler`: This handles any errors that occur throughout the entire middleware process. Typically, you would write your own custom `errorHandler` that might render a default 404 HTML page, or log the error to a data store, and so on.

The `app.use(app.router)` line is a special component of Express that says you are actually using a router with your server, and you can respond to requests such as `GET`, `POST`, `PUT`, and `UPDATE`. Since you are using the Express router as one of the last middleware, we will also define the actual routes in the next section.

Finally, the `connect.static()` middleware is used to render static content files to the browser from a predefined static resource directory. This is important so that the server can serve up static files such as `.js`, `.css`, images, regular `.html`, as well as any other files you might need to serve up. The static middleware will serve up any static files from the public directory like the following code:

```
http://localhost:3300/public/js/somescript.js

http://localhost:3300/public/img/main_logo.jpg
```

It's important that your static middleware is defined after the `app.router()` so that static assets aren't inadvertently taking priority over a matching route that you may have defined.

Activating the configure module

Now that your `configure.js` file is complete, you're ready to call it from your main `server.js` file. If you recall, we included two lines of code that were commented out for our configure module. Its time to uncomment those two lines so that when you run your server, your configure module will do its part. The two lines should now look like:

```
config = require('./server/configure'),

app = config(app);
```

Boot up your server again by executing `node server.js` and everything should still be running smoothly. (Although, the app still doesn't actually do anything yet.) If you point your browser to `http://localhost:3300`, you'll still get the same error. However, this time, you will see `GET /` with a 404 log to your terminal thanks to the Connect logger middleware.

When you run your app, you might receive warnings similar to **connect.multipart() will be removed in Connect 3.0**. This is because Express comes bundled with an older version of Connect and depends fairly heavily on it. With Express Version 4, this dependency has been removed and the Connect framework middleware has been broken down into smaller, separate pieces. More on this is covered in the section later in this chapter, which is related to migrating to Express Version 4.

Routers and controllers

So far, you have your `server.js` file and a `configure` module that is used to wire up all of the necessary middleware for the application. The next step is to implement a proper router and controller.

The router is going to be a map of each of the available URL paths for the app. Every route on the server will correspond to a function in a controller. Here is what our routes table will look like for the particular application we are writing:

```
GET  /(index) - home.index (render the homepage of the site)
GET  /images/image_id - image.index (render the page for a specific image)
POST /images - image.create (when a user submits and uploads a new image)
POST /images/image_id/like - image.like (when a user clicks the Like button)
POST /images/image_id/comment - image.comment (when a user posts a comment)
```

You can see that we are handling two different `GET` requests and three different `POST` requests. In addition, we have two main controllers: `home` and `image`. Controllers are really just modules with different functions defined that match up to the corresponding routes. We're calling them controllers because we're using the MVC design pattern, or Model View Controller. Typically, every route will correspond to a controller. This controller will more than likely render a view, and that view will more than likely have its own model (any data that is displayed in the view). You can learn more about MVC by visiting the following Wikipedia page:

`http://en.wikipedia.org/wiki/Model-view-controller`

Let's write our router as its own module, matching the table I outlined. First, create a `routes.js` file within the `server` folder. The routes file is going to be pretty simple, and the only dependencies it requires will be the controllers we define:

```
var home = require('../controllers/home'),
    image = require('../controllers/image');

module.exports.initialize = function(app) {
    app.get('/', home.index);
    app.get('/images/:image_id', image.index);

    app.post('/images', image.create);
    app.post('/images/:image_id/like', image.like);
    app.post('/images/:image_id/comment', image.comment);
};
```

Right off the bat, we declare variables for both of our controllers and require each from the `controllers` folder (we haven't yet created these files but that's coming up next). Then, we export a module that contains an `initialize` function, which accepts our application as its only parameter. Inside the module, we define each of our routes.

The first parameter for a route is the string value of the route itself, which can contain variable values as sub paths. You can see with second `app.get`, we assign a route value of `'/images/:image_id'` that basically equates to `'/image/ANYVALUE'` in the browser address bar. When we write the `image.index` controller, you will see how to retrieve the value for `:image_id` and use it within the controller function itself.

The second parameter for a route is a callback function. You can completely omit the idea of using controllers and just define your callbacks as inline anonymous functions; however, as your routes grow, this file will get larger and larger, and the code will start to become a mess. It's always good practice to break your code up into as many small and manageable modules as possible to keep yourself sane!

The first two `app.get` routes are typical routes that would be called whenever a visitor points their browser to `yourdomain.com/routepath`—the browser by default sends a `GET` request to the server. The other three `app.post` routes are defined to handle when the browser `POST`s a request to the server, typically done via an HTML form submission.

With all of our routes defined, let's now create the matching controllers. Within the `controllers` folder, create both the `home.js` and `image.js` files. The `home.js` file is very basic:

```
module.exports = {
    index: function(req, res) {
        res.send('The home:index controller');
    }
};
```

With this module, we are actually exporting an object that has a single function called `index`. The function signature for `index` is the signature that is required for every route using Express. The first parameter is a request object and the second parameter is a response object. Every detail specific to the request that the browser sent to the server will be available via the request object. In addition, the request object will be modified using all of the middleware that was declared earlier. You will use the response object to send a response back to the client—this may be a rendered HTML page, static asset, JSON data, an error, or whatever you determine. For now, our controllers just respond with simple text so you can see that they are all working.

Let's create the image controller that has a few more functions. Edit the `/controllers/image.js` file and insert the following code:

```
module.exports = {
    index: function(req, res) {
        res.send('The image:index controller ' + req.params.image_id);
    },
    create: function(req, res) {
        res.send('The image:create POST controller');
    },
    like: function(req, res) {
        res.send('The image:like POST controller');
    },
    comment: function(req, res) {
        res.send('The image:comment POST controller');
    }
};
```

Here, we defined the index function, just like we did in the home controller, except that we will also display `image_id` that is set in the route when this controller function is executed. The `params` property was added to the request object via the `urlencoded` Connect middleware!

Take note that neither controller currently requires any dependencies (there were no `require` declarations defined at the top of the file). This will change as we actually flesh out the controller functions and start to do things such as inserting records into our MongoDB database and using other third-party npm modules.

Now that your controllers are created and ready to be used, you just need to activate your routes. To do this, we will insert one last line of code in our `configure.js` file, right above the `return app;` line:

```
routes.initialize(app);
```

Don't forget to uncomment the `routes = require('./routes'),` line at the top of the file as well. What we're doing here is using the routes module we defined and executing the `initialize` function, which will actually wire up our routes via our app object.

As a recap of each of the files you have created so far, here are the uninterrupted files listed so you can view the full code:

1. First, we have the boot up with `server.js`:

```
var express = require('express'),
    config = require('./server/configure'),
    app = express();

app.set('port', process.env.PORT || 3300);
app.set('views', __dirname + '/views');
app = config(app);

var server = app.listen(app.get('port'), function() {
    console.log('Server up: http://localhost:' + app.get('port'));
});
```

2. Next, we will configure the server with `server/configure.js`:

```
var connect = require('connect'),
    path = require('path'),
    routes = require('./routes'),
    exphbs = require('express3-handlebars');

module.exports = function(app) {
    app.engine('handlebars', exphbs.create({
        defaultLayout: 'main',
        layoutsDir: app.get('views') + '/layouts',
        partialsDir: [app.get('views') + '/partials']
    }).engine);
    app.set('view engine', 'handlebars');
```

```
    app.use(connect.logger('dev'));
    app.use(connect.bodyParser({
        uploadDir:path.join(__dirname, '../public/upload/temp')
    }));
    app.use(connect.json());
    app.use(connect.urlencoded());
    app.use(connect.methodOverride());
    app.use(connect.cookieParser('some-secret-value-here'));
    app.use(app.router);
    app.use('/public/', connect.static(path.join(__dirname, '../
public')));

    if ('development' === app.get('env')) {
        app.use(connect.errorHandler());
    }

    routes.initialize(app);

    return app;
};
```

3. Then, we have our routes defined in `server/routes.js`:

```
var home = require('../controllers/home'),
    image = require('../controllers/image');

module.exports.initialize = function(app) {
    app.get('/', home.index);
    app.get('/images/:image_id', image.index);

    app.post('/images', image.create);
    app.post('/images/:image_id/like', image.like);
    app.post('/images/:image_id/comment', image.comment);
};
```

4. Finally, we will define our controllers with `controllers/home.js`:

```
module.exports = {
    index: function(req, res) {
        res.send('The home:index controller');
    }
};
```

And `controllers/image.js`:

```
module.exports = {
    index: function(req, res) {
        res.send('The image:index controller ' + req.params.image_
id);
    },
```

```
        create: function(req, res) {
            res.send('The image:create POST controller');
        },
        like: function(req, res) {
            res.send('The image:like POST controller');
        },
        comment: function(req, res) {
            res.send('The image:comment POST controller');
        }
    };
```

Let's fire up the server one last time and check whether it's all working. Execute `node server.js`, and this time point your browser to `http://localhost:3300`. Now, you should be seeing some responses in the browser. Try going to `http://localhost:3300/images/testing123`. You should see **The image:index controller testing123** on the screen!

Custom middleware

There will undoubtedly come a time when you want to write your own custom middleware in addition to the existing middleware provided by Connect or any other third party. Before you write your own custom anything in Node, make it a habit to search through `https://www.npmjs.org/` first, as there's a fairly big chance someone else has already done the work.

Writing your own custom middleware is pretty simple. You simply need to write a function that accepts four parameters: `err`, `req`, `res`, and `next`. The first parameter is an error object, and if there were any stack errors prior to your middleware running, that error will be passed to your middleware so you can handle accordingly. You are already familiar with the `req` and `res` parameters having written your routes. The fourth parameter is actually a reference to a callback. This `next` parameter is how the middleware stack is able to behave like a stack—each executing and ensuring that the next middleware in the pipeline is returned and called via `next`. Here is a super basic example of a custom middleware:

```
app.use(function(err, req, res, next) {
    // do whatever you want here, alter req, alter res, throw err,
etc.
    return next();
});
```

The only important thing to keep in mind when writing your own custom middleware is that you have the correct parameters and that you return `next()`. The rest is completely up to you!

Migrating to Express v4.0.0

The biggest change that comes with Express Version 4.0 is that Connect is no longer a dependency. Additionally, most of Express's (and subsequently Connect's) bundled middleware has been stripped out and moved into individual repositories. This is to help speed up the development and release cycles for both the newly separated middleware modules as well as Express itself. The only middleware that remains is `express.static` (for convenience). The good news here is that we're no longer required to use Express's (and by proxy Connect's) middleware by default!

The other big change is the way routes work. In previous versions the router was a part of the middleware and the routes were all defined as `app.verb()`. Now, you can either define a route object per route or just define routes by calling `app.route('route').verb(callback)`. Let's go through the process of modifying our existing code so that it is ready to use Express Version 4.0.

Please note that the remainder of this section is devoted to migrating your code to use Express Version 4.x. The remainder of the book, however, continues to assume that you are using Express Version 3.5.x as the code reflects as such.

Using new middleware

One of the first things we want to do is completely remove Connect and install the new dependencies that will replace Connect. Execute the following command to install the new packages:

```
$ npm install express@4.0.0 morgan body-parser cookie-parser method-
override errorhandler --save
```

This will not only upgrade your version of Express to 4.0.0 but also include all of the additional middleware we will be using in place of Connect. Some of these packages aren't the most self-explanatory (unfortunately), but you'll see what each is used for in the upcoming section. Your `package.json` file should now look something like this:

```
"dependencies": {
  "express": "^4.0.0",
  "morgan": "~1.0.0",
  "body-parser": "~1.0.0",
  "cookie-parser": "~1.0.0",
```

```
    "method-override": "~1.0.0",
    "errorhandler": "~1.0.0",
    "express3-handlebars": "^0.5.0"
  }
```

Next, we will want to make some changes to the `server/configure.js` and `server/routes.js` files.

server/configure.js

We are going to be changing the way our router behaves a little bit, so we need to make some modifications to how the router is configured (and the order in which it is configured). First, remove the `app.use(app.router)` line and replace it with the `routes.initialize(app)` line (that was towards the bottom). In addition, include a second parameter with the `routes.initalize(app)` line so that it looks like the following:

```
routes.initialize(app, new express.Router());
```

We are creating a new `express.Router()` object and passing it in our `routes` module as the second parameter.

Next, require each of the new dependencies, including `express`, and remove Connect (at the top of the `server/configure.js` file):

```
var path = require('path'),
    routes = require('./routes'),
    exphbs = require('express3-handlebars'),
    express = require('express'),
    bodyParser = require('body-parser'),
    cookieParser = require('cookie-parser'),
    morgan = require('morgan'),
    methodOverride = require('method-override'),
    errorHandler = require('errorhandler');
```

Replace the middleware that was originally set up to use Connect to use the new modules instead.

Replace the `connect.logger` middleware with its replacement `morgan`:

```
//app.use(connect.logger('dev'));
app.use(morgan('dev'));
```

Replace the `connect.bodyParser`, `connect.json`, and `connect.urlencoded` middleware with a replacement `bodyParser`:

```
// app.use(connect.bodyParser({
//     uploadDir:path.join(__dirname, '../public/upload/temp')
// }));
// app.use(connect.json());
// app.use(connect.urlencoded());
app.use(bodyParser({
    uploadDir:path.join(__dirname, '../public/upload/temp')
}));
```

Replace the `connect.methodOverride` middleware with its replacement `methodOverride`:

```
// app.use(connect.methodOverride());
app.use(methodOverride());
```

Replace `connect.cookieParser` with its replacement `cookieParser`:

```
// app.use(connect.cookieParser('some-secret-value-here'));
app.use(cookieParser('some-secret-value-here'));

routes.initialize(app, new express.Router());
```

Replace `connect.static` with the built-in `express.static` replacement middleware:

```
// app.use('/public/', connect.static(path.join(__dirname, '../
public')));
app.use('/public/', express.static(path.join(__dirname, '../
public')));
```

Finally, replace `connect.errorHandler` with its replacement `errorHandler`:

```
if ('development' === app.get('env')) {
    // app.use(connect.errorHandler());
    app.use(errorHandler());
}
```

Note that each of the original `connect` middleware was commented out in the preceding code so that you can clearly see what was replaced where. Feel free to actually delete those lines in your own code. The final condensed version of the previous code in `server/configure.js` should look as follows:

```
var path = require('path'),
    routes = require('./routes'),
    exphbs = require('express3-handlebars'),
    express = require('express'),
    bodyParser = require('body-parser'),
    cookieParser = require('cookie-parser'),
    morgan = require('morgan'),
    methodOverride = require('method-override'),
    errorHandler = require('errorhandler');

module.exports = function(app) {
    app.engine('handlebars', exphbs.create({
        defaultLayout: 'main',
        layoutsDir: app.get('views') + '/layouts',
        partialsDir: [app.get('views') + '/partials']
    }).engine);
    app.set('view engine', 'handlebars');

    app.use(morgan('dev'));
    app.use(bodyParser({
        uploadDir:path.join(__dirname, '../public/upload/temp')
    }));
    app.use(methodOverride());
    app.use(cookieParser('some-secret-value-here'));

    routes.initialize(app, new express.Router());

    app.use('/public/', express.static(path.join(__dirname, '../
public')));

    if ('development' === app.get('env')) {
        app.use(errorHandler());
    }

    return app;
};
```

server/routes.js

Next, we will rewrite the original routes to use the new `express.Router()` object. The main change here is that we are accepting a new `Router` object as a parameter to our `initialize()` function and using `router.verb()` instead of `app.verb()` for each of the routes:

```
var home = require('../controllers/home'),
    image = require('../controllers/image');

module.exports.initialize = function(app, router) {
    router.get('/', home.index);
    router.get('/images/:image_id', image.index);
    router.post('/images', image.create);
    router.post('/images/:image_id/like', image.like);
    router.post('/images/:image_id/comment', image.comment);

    app.use('/', router);
};
```

And that's it! Your app has been successfully migrated from Express 3.5.x to 4.0! Remember, the remainder of this book will continue to use Express 3.5.x, so the completed migration changes wont be reflected in the remaining code we write.

If you want, you can continue to use the Connect middleware framework and save a lot of work during the migration, but I wanted to show you how the new middleware works with Express 4.0.

Summary

In this chapter, we learned about the Express web framework for Node and wrote a basic web server from scratch that will act as the foundation for the image uploading website that we will build throughout the remainder of the book.

The web server you wrote handles requests to specific routes, uses controllers to handle the logic for those routes, and supports all of the standard requirements a typical web server should.

In the next chapter, we will cover using the Handlebars template engine to write each of the dynamic HTML pages that the website needs. In addition, we will update the `image` and `home` controllers to include the necessary logic to properly render those HTML pages.

5
Dynamic HTML with Handlebars

One of the most important features when creating a website is the ability to display dynamic content on an HTML page. The difference between dynamic content and static content is that dynamic content is typically generated via conditional statements and/or varying data (usually retrieved from a database). In order to generate parts of an HTML page during runtime, you will need some sort of rendering engine. There are many different rendering engines available that can be used with Node and Express. The particular engine we chose for this book is Handlebars.js—named for the syntax use of {{ and }} that resembles a handlebar mustache!

Basic syntax for Handlebars

The basic syntax for Handlebars is really quite simple. Let's assume the following JavaScript object is passed to a Handlebars template:

```
var model = {
  name: 'World'
};
```

The template file itself will contain the following markup:

```
<div>
  Hello {{ name }}!
</div>
```

This file would render to a browser in the following way:

```
Hello World!
```

Of course, there's a lot more that you can do than just this! Handlebars also supports conditional statements:

```
var model = {
  name: 'World',
  description: 'This will only appear because its set.'
};

<div>
   Hello {{ name }}!<br/><br/>
  {{#if description}}
     <p>{{description}}</p>
  {{/if}}
</div>
```

Using an `if` block helper as shown in the preceding code, you can check for truthy conditionals and only display HTML and/or data if the condition is true. Alternatively, you can use the `unless` helper to do the opposite, and display HTML only if a condition is falsey:

```
var model = {
  name: 'World'
};

<div>
   Hello {{ name }}!<br/><br/>
  {{#unless description}}
     <p>NOTE: no description found.</p>
  {{/if}}
</div>
```

You can use both `if` and `else` as well as `unless` the same way you would use conditional `if/else` in other programming languages.

Views

A view is what we are referring to as an HTML page. They are called views because of the **Model View Controller** (**MVC**) design pattern. Actually, the pattern we're using is closer to that of **Model, View, ViewModel** (**MVVM**). Typically, a Model is the data that is going to be displayed on a page (again, in our case known as a ViewModel), the View is the page itself, and the Controller is the brain that communicates between the ViewModel and the View.

Our particular application is going to need two views. The first view is the home page, and the second view is the image page.

The HTML in the following section relies heavily on Bootstrap, a popular HTML framework created by Twitter that provides a standard set of user interface elements. These include buttons, fonts, layout grids, color schemes, and a whole lot more. Using Bootstrap allows us to not only present our application with a nice clean UI, but also build it so that it is responsive and will look correct on any device that is viewing it. You can learn more about Bootstrap by visiting `http://getbootstrap.com`.

Let's start by creating the home page view. Create a new file within the `views` folder, name it `index.handlebars`, and insert the following HTML code:

```
<div class="panel panel-primary">
    <div class="panel-heading">
        <h3 class="panel-title">
            Upload an Image
        </h3>
    </div>
```

The reason we named our file `index.handlebars` is purely personal choice, but it is also based on common naming conventions on the Web. Typically, an HTML page that acts as the root file for any website is named `index.whatever` (.php, .aspx, .html, and so on). Again, this is just common convention and not something you need to specifically adhere to.

Create a basic HTML form and set the method to `POST` and action to `/images`. Be sure to set the `enctype` attribute of the form since we will be uploading files as well as submitting data via form fields:

```
    <form method="post" action="/images" enctype="multipart/form-
data">
        <div class="panel-body form-horizontal">
            <div class="form-group col-md-12">
                <label class="col-sm-2 control-label"
for="file">Browse:</label>
```

Here, we have included a standard HTML input field for the file to be uploaded:

```
                <div class="col-md-10">
                    <input class="form-control" type="file"
name="file">
                </div>
            </div>
            <div class="form-group col-md-12">
                <label class="col-md-2 control-label"
for="title">Title:</label>
                <div class="col-md-10">
```

Another standard HTML input field for the title of the file can be whatever the user wants, as shown in the following code:

```
                    <input class="form-control" type="text"
name="title">
                </div>
            </div>
            <div class="form-group col-md-12">
                <label class="col-md-2 control-label"
for="description">Description:</label>
                <div class="col-md-10">
```

And a standard HTML `textarea` input field to allow for a description is as follows:

```
                    <textarea class="form-control" name="description"
rows="2"></textarea>
                </div>
            </div>
            <div class="form-group col-md-12">
                <div class="col-md-12 text-right">
```

A standard HTML button is provided that will submit the form to the server. Using Bootstrap classes, we provide `btn` and `btn-success` to make this look like a Bootstrap-style button with the default color for success (green):

```
                    <button type="submit" id="login-btn" class="btn
btn-success" type="button"><i class="fa fa-cloud-upload "></i> Upload
Image</button>
                </div>
            </div>
        </div>
    </form>
</div>
```

After the upload form section, we will display a list of the newest images uploaded to the website:

```
<div class="panel panel-default">
    <div class="panel-heading">
        <h3 class="panel-title">
            Newest Images
        </h3>
    </div>
    <div class="panel-body">
        {{#each images}}
            <div class="col-md-4 text-center" style="padding-bottom:
1em;"><a href="/images/{{ uniqueId }}"><img src="/public/upload/
{{filename}}" alt="{{title}}" style="width: 175px; height: 175px;"
class="img-thumbnail"></a></div>
        {{/each}}
    </div>
</div>
```

There are two important sections in the main home page HTML code. The first is the form we define that will be the main way users will upload images to the website. As we will be accepting image files as well as the details for the image (title, description, and so on), we need to ensure that the form is set up to accept multipart data. We also set the form action to point to the `/images` route we defined earlier in our `routes` and `image` controller modules. When a user completes the form and clicks on the **Submit** button, the form will send a `POST` request to `http://localhost:3300/images`, and our router will catch that and forward it to our `image` controller. From there, the `image` controller will handle processing the data and saving it to the database, saving the image file to the filesystem, and redirecting to the image details page. We will actually be writing this logic in the next chapter. For now, nothing will actually happen if you submit the form.

Below the main image uploading form on the home page, we also have a section that performs a Handlebars loop using `each` and iterates through an image collection, displaying each image as a thumbnail and the link to the image page. The `images` collection will be populated from our `home` controller when we build its ViewModel. It's important to take note here that when you are inside an `{{#each}}` loop in a Handlebars template, your context changes. That is, the path you use to access data inside `each` is now based on each item in the collection. Here, our ViewModel will have an image collection, and each item in the image collection will have a property for `uniqueid`, `filename`, and `title`. With the home page view out of the way, let's set up the view for the image page.

Create another file in the `views` folder named `image.handlebars`. This file is going to have a bit more functionality, so I'm going to break it down into chunks so we can review each section. First, insert the following block of code:

```
<div class="panel panel-primary">
    <div class="panel-heading">
        <h2 class="panel-title">{{ image.title }}</h2>
    </div>
    <div class="panel-body">
        <p>{{ image.description }}</p>
        <div class="col-md-12 text-center">
            <img src="/public/upload/{{image.filename}}" class="img-
thumbnail">
        </div>
    </div>
    <div class="panel-footer">
        <div class="row">
            <div class="col-md-8">
                <button class="btn btn-success" id="btn-like" data-
id="{{ image.uniqueId }}"><i class="fa fa-heart"> Like</i></button>
                <strong class="likes-count">{{ image.likes }}</strong>
  -   <i class="fa fa-eye"></i> <strong>{{ image.views }}</
strong>
                  -   Posted: <em class="text-muted">{{
timeago image.timestamp }}</em>
            </div>
        </div>
    </div>
</div>
```

This block of code defines the bulk of the content that will be displayed on the page for a specific image. The ViewModel for this page is going to consist of an image object that has various properties defined that you see being used throughout the code; properties such as `title`, `description`, `filename`, `likes`, and `views`.

You may have noticed a slightly different piece of syntax in there specific to the `{{ timeago image.timestamp }}` timestamp. That is actually a Handlebars helper. It is a custom function we will write shortly that will do some special string formatting—specifically, converting a timestamp string to how long it was sometime ago (that is, 2 days ago, 12 hours ago, 15 minutes ago, and so on).

We want to allow users to post comments to images, so let's include a simple form for that:

```
<div class="panel panel-default">
    <div class="panel-heading">
        <div class="row">
            <div class="col-md-8">
                <strong class="panel-title">Comments</strong>
            </div>
            <div class="col-md-4 text-right">
                <button class="btn btn-default btn-sm" id="btn-
comment" data-id="{{ image.uniqueId }}"><i class="fa fa-comments-o">
Post Comment...</i></button>
            </div>
        </div>
    </div>
    <div class="panel-body">
        <blockquote id="post-comment">
            <div class="row">
```

The following is another standard HTML form with the method and action set. This form allows a user to enter, via standard HTML input fields, his/her name, e-mail address, and comments. Another submit button is provided to save the comment:

```
                <form method="post" action="/images/{{ image.uniqueId
}}/comment">
                    <div class="form-group col-sm-12">
                        <label class="col-sm-2 control-label"
for="name">Name:</label>
                        <div class="col-sm-10">
                            <input class="form-control" type="text"
name="name">
                        </div>
                    </div>
                    <div class="form-group col-sm-12">
                        <label class="col-sm-2 control-label"
for="email">Email:</label>
                        <div class="col-sm-10">
                            <input class="form-control" type="text"
name="email">
                        </div>
                    </div>
                    <div class="form-group col-sm-12">
```

```
                        <label class="col-sm-2 control-label"
for="comment">Comment:</label>
                        <div class="col-sm-10">
                            <textarea class="form-control"
name="comment" rows="2"></textarea>
                        </div>
                    </div>
                    <div class="form-group col-sm-12">
                        <div class="col-sm-12 text-right">
                            <button type="submit" id="comment-btn"
class="btn btn-success" type="button"><i class="fa fa-comment"></i>
Post</button>
                        </div>
                    </div>
                </form>
            </div>
        </blockquote>
```

The form action for comments is set to `/images/{{ image.uniqueid }}/comment`. Again, if you recall from the routes we set up, we specifically defined a route to handle this.

Finally, we want to display any comments that have been submitted for this image. Our ViewModel includes a collection of comments in addition to the image details, so we can simply iterate over that collection using the Handlebars `#each` block helper:

```
        <ul class="media-list">
            {{#each comments}}
            <li class="media">
                <a class="pull-left" href="#">
                    <img class="media-object img-circle" src="http://
www.gravatar.com/avatar/{{gravatar}}?d=monsterid&s=45">
                </a>
                <div class="media-body">
                    {{ comment }}
                    <br/><strong class="media-heading">{{ name }}</
strong> <small class="text-muted">{{ timeago timestamp }}</small>
                </div>
            </li>
            {{/each}}
        </ul>
    </div>
</div>
```

Much like the loop we perform on the home page to display a collection of images, here we simply iterate through every comment in the `comments` collection and display the comment and string-formatted timestamp (again using our `timeago` global helper). We are also using Gravatar to display universal avatar images for users who have commented (assuming they provided their e-mail addresses).

Gravatar is a service provided by `https://wordpress.com/` that allows a user's personal profile image to be provided via his/her e-mail address. Many popular web services rely on Gravatar as a quick and easy way to display a user's personal profile image, without requiring the additional functionality to support such a feature. You can learn more about Gravatar at `http://gravatar.com`.

Layouts

So far we've created two specific views for our website, one for the home page and one for the details of an image. However, there's no consistent UI wrapping both of these pages together. We have no consistent navigation or logo. There's no common footer with standard copyright or additional information.

Usually, with any website that you create, you're going to want to have some form of a standard layout or master template that every page will use. This layout typically includes the website logo and title, main navigation, sidebar (if any), and the footer. It would be bad practice to include the HTML code for the layout in every single page on our website because if we wanted to make even the smallest change to the main layout, we would have to edit every single page as a result. Fortunately, Handlebars helps lessen the work of utilizing a layout file.

Let's create a layout file for our app by creating a new file named `main.handlebars` within the `views/layouts` folder and inserting the following HTML code:

```
<!DOCTYPE HTML>
<html lang="en">
    <head>
        <title>imgPloadr.io</title>
        <link href="//netdna.bootstrapcdn.com/bootstrap/3.1.1/css/
bootstrap.min.css" rel="stylesheet">
        <link href="//netdna.bootstrapcdn.com/font-awesome/4.0.3/css/
font-awesome.min.css" rel="stylesheet">
        <link rel="stylesheet" type="text/css" href="/public/css/
styles.css">
    </head>
```

```
    <body>
        <div class="page-header">
            <div class="container">
                <div class="col-md-6">
                    <h1><a href="/">imgPloadr.io</a></h1>
                </div>
            </div>
        </div>
        <div class="container">
            <div class="row">
                <div class="col-sm-8">
                    {{{ body }}}
                </div>
                <div class="col-sm-4">
                    {{> stats this }}

                    {{> popular this }}

                    {{> comments this }}
                </div>
            </div>
        </div>
        <div style="border-top: solid 1px #eee; padding-top: 1em;">
            <div class="container">
                <div class="row">
                    <div class="col-sm-12 text-center">
                        <p class="text-muted">imgPloadr.io | &copy;
Copyright 2014, All Rights Reserved</p>
                        <p class="text-center">
                            <i class="fa fa-twitter-square fa-2x text-
primary"></i>
                            <i class="fa fa-facebook-square fa-2x
text-primary"></i>
                        </p>
                    </div>
                </div>
            </div>
        </div>
        <script src="//ajax.googleapis.com/ajax/libs/jquery/1.11.0/
jquery.min.js"></script>
        <script type="text/javascript" src="/public/js/scripts.js"></
script>
    </body>
</html>
```

Most of the preceding code is just HTML, and a lot of it uses Bootstrap for the actual physical layout of the page as well as a few other UI-related elements. The most important part is the highlighted section in the middle with `{{{ body }}}` and the few lines below that, as they pertain to the use of Handlebars.

`{{{ body }}}` is a reserved word in Handlebars that is used specifically with layouts. What we are basically saying is that any page we render that's using our default layout file will have its content inserted to the area where `{{{ body }}}` is defined. If you recall from the `configure` module we created earlier, we defined our default layout file when we set up Handlebars as our rendering engine. The slightly odd use of `{{{` and `}}}` around the body is due to the fact that Handlebars escapes HTML by default when using `{{` and `}}`. Since our views contain mostly HTML, we want this to stay intact so that we use `{{{` and `}}}` instead.

The other three lines that use `{{ > ... }}` render Handlebars partials, which are like shared HTML code blocks that we will learn about next.

Partial views

So far we've created a View, which acts as the bulk of the HTML for a specific page, and a layout, which acts as the wrapper for the consistent parts of the website on every page. Next up, let's take a look at creating partials, which are really just small views that we can reuse and inject inside our layouts or views.

Partials are a terrific way to create reusable components in your website and reduce code duplication. Consider the comments in our application. We have an HTML form defined that a user uses to submit a comment, but what if we wanted to allow users to post comments from a number of different areas throughout the website. This type of scenario is a great candidate for moving our comment form out to its own partial and then just including that partial anywhere we want to display the comment form.

For this app, we're using partials specifically for the sidebar in the main layout. With every view's ViewModel, we will include a JavaScript object called `sidebar` that will contain the data specifically for the stats, popular images, and recent comments found within the sidebar partial.

Let's create the HTML for each of the partials. First, create a file named `stats.handlebars` within the `views/partials/` path and include the following HTML code:

```
<div class="panel panel-default">
    <div class="panel-heading">
        <h3 class="panel-title">
```

```
            Stats
        </h3>
    </div>
    <div class="panel-body">
        <div class="row">
            <div class="col-md-2 text-left">Images:</div>
            <div class="col-md-10 text-right">{{ sidebar.stats.images
}}</div>
        </div>
        <div class="row">
            <div class="col-md-2 text-left">Comments:</div>
            <div class="col-md-10 text-right">{{ sidebar.stats.
comments }}</div>
        </div>
        <div class="row">
            <div class="col-md-2 text-left">Views:</div>
            <div class="col-md-10 text-right">{{ sidebar.stats.views
}}</div>
        </div>
        <div class="row">
            <div class="col-md-2 text-left">Likes:</div>
            <div class="col-md-10 text-right">{{ sidebar.stats.likes
}}</div>
        </div>
    </div>
</div>
```

Next up, create `views/partials/popular.handlebars` and insert the following HTML code into it:

```
<div class="panel panel-default">
    <div class="panel-heading">
        <h3 class="panel-title">
            Most Popular
        </h3>
    </div>
    <div class="panel-body">
        {{#each sidebar.popular}}
            <div class="col-md-4 text-center" style="padding-
bottom: .5em;"><a href="/images/{{uniqueId}}"><img src="/public/
upload/{{filename}}" style="width: 75px; height: 75px;" class="img-
thumbnail"></a></div>
        {{/each}}
    </div>
</div>
```

Finally, create `views/partials/comments.handlebars` and insert the following HTML code into it:

```
<div class="panel panel-default">
    <div class="panel-heading">
        <h3 class="panel-title">
            Latest Comments
        </h3>
    </div>
    <div class="panel-body">
        <ul class="media-list">
            {{#each sidebar.comments}}
            <li class="media">
                <a class="pull-left" href="/images/{{ image.uniqueId
}}">
                    <img class="media-object" width="45" height="45"
src="/public/upload/{{ image.filename }}">
                </a>
                <div class="media-body">
                    {{comment}}<br/>
                    <strong class="media-heading">{{name}}</strong>
<small class="text-muted">{{timeago timestamp }}</small>
                </div>
            </li>
            {{/each}}
        </ul>
    </div>
</div>
```

Handlebars Helpers

Handlebars supports the idea of helpers, which are special custom functions you can write to perform some special logic from within the template during runtime. A great example of a helper would be the date string formatter we've been using. Helpers can be registered globally and made available to every template file, or they can be defined per view and passed to the template on an as needed basis as a part of the ViewModel.

Global helpers

First, let's create a global helper that will be available to every Handlebars template we render. This global helper that you will create will be used to format a timestamp so that it is worded as to how long ago the event occurred. We will use this throughout our application for things such as comments and image timestamps.

The first thing we need to do is update our `server/configure.js` module, where we originally initially configured Handlebars as our rendering engine. We are going to add a section to define our helpers:

```
app.engine('handlebars', exphbs.create({
    defaultLayout: 'main',
    layoutsDir: app.get('views') + '/layouts',
    partialsDir: [app.get('views') + '/partials'],
    helpers: {
        timeago: function(timestamp) {
            return moment(timestamp).startOf('minute').fromNow();
        }
    }
}).engine);
```

As you can see from the additional code we added (highlighted in the preceding code), we defined the `helpers` property of the configuration options within `create()`, and inside the `helpers` property, we can define any number of functions we want. In this case, we defined a simple `timeago` function that actually uses another npm module called `moment`. The `moment` module is a great library for doing a number of different date string formatting. As we are using a new module, we need to be sure to perform `require()` at the top of our `configure` module:

```
var connect = require('connect'),
    path = require('path'),
    routes = require('./routes'),
    exphbs = require('express3-handlebars'),
    moment = require('moment');
```

As well as actually install it via npm:

```
$ npm install moment --save
```

View-specific helpers

While defining helpers globally is nice because they are available to every view that's rendered, sometimes you might only need to define a helper for use within a single view. In this case, you can include the helper right with the ViewModel itself when calling `res.render()`, as shown in the following code:

```
var viewModel = {
  name: 'Jason',
helpers: {
    timeago: function(timestamp) {
```

```
    return 'a long time ago!';
          }
}
};
res.render('index', viewModel);
```

Not only are we defining a custom helper that can be used specifically from this view in its ViewModel, but in this particular instance we are overriding the existing `timeago` global helper with a slightly different version that is perfectly valid.

Rendering the views

Let's take a minute to do a quick recap and see what we've done up to this point. So far, we have:

- Created `index.handlebars` and `image.handlebars`—the views for the two main pages of the application
- Created `layouts/main.handelbars`—the main layout file for every page in the application
- Created `partials/comments.handlebars`, `popular.handlebars`, and `stats.handlebars`
- Created a global `timeago` Handlebars helper

So far so good; however, none of these views actually do anything, receive any ViewModels, or even appear when you run the application! Let's make a few quick minor modifications to our controllers to get our views to render properly.

Open `/controllers/home.js` so that you can edit the `home` controller module. Update the contents of that file so that it looks identical to the following block of code:

```
module.exports = {
    index: function(req, res) {
        res.render('index');
    }
};
```

Instead of performing `res.send`, which just sends a simple response, we are calling `res.render` and passing in the name of the template file we want to render as the only parameter (for now). Using the defaults that were defined in our configure module, the index file will be loaded from our `views` folder. Again, also using the defaults, we configured the default layout of `main` that will be applied to this view in our `configure` module.

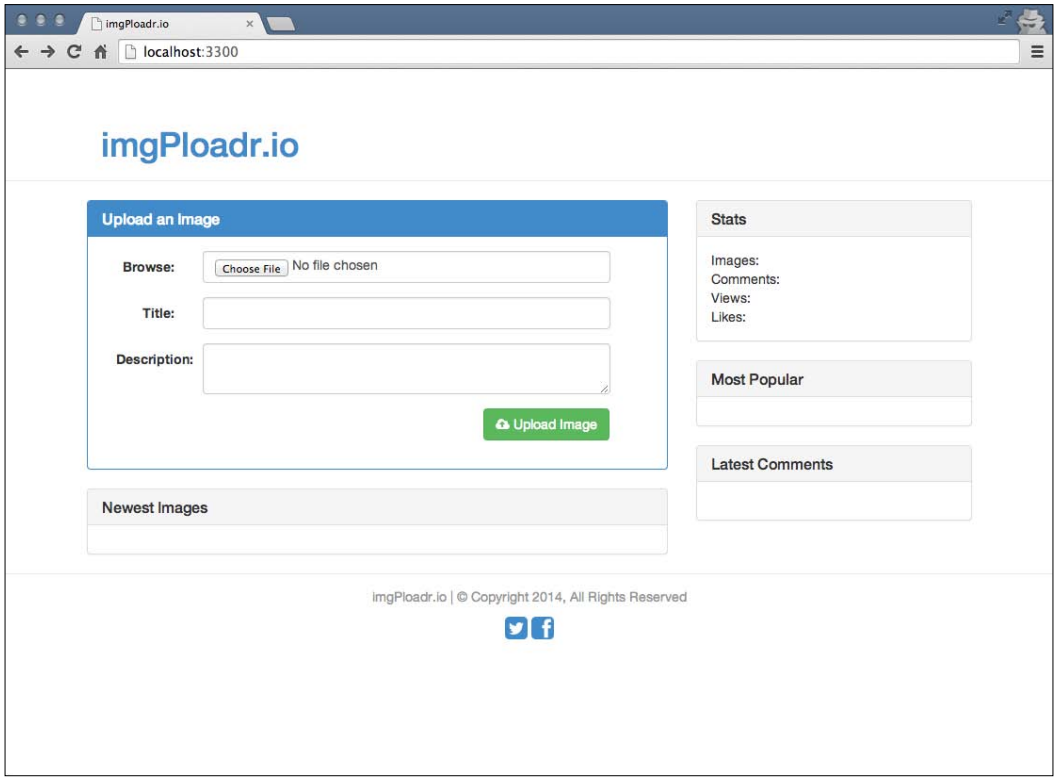
Let's update the `image` controller as well to do the same thing. Edit `/controllers/image.js` and change the `index` function so that it looks identical to the following block of code:

```
index: function(req, res) {
    res.render('image');
},
```

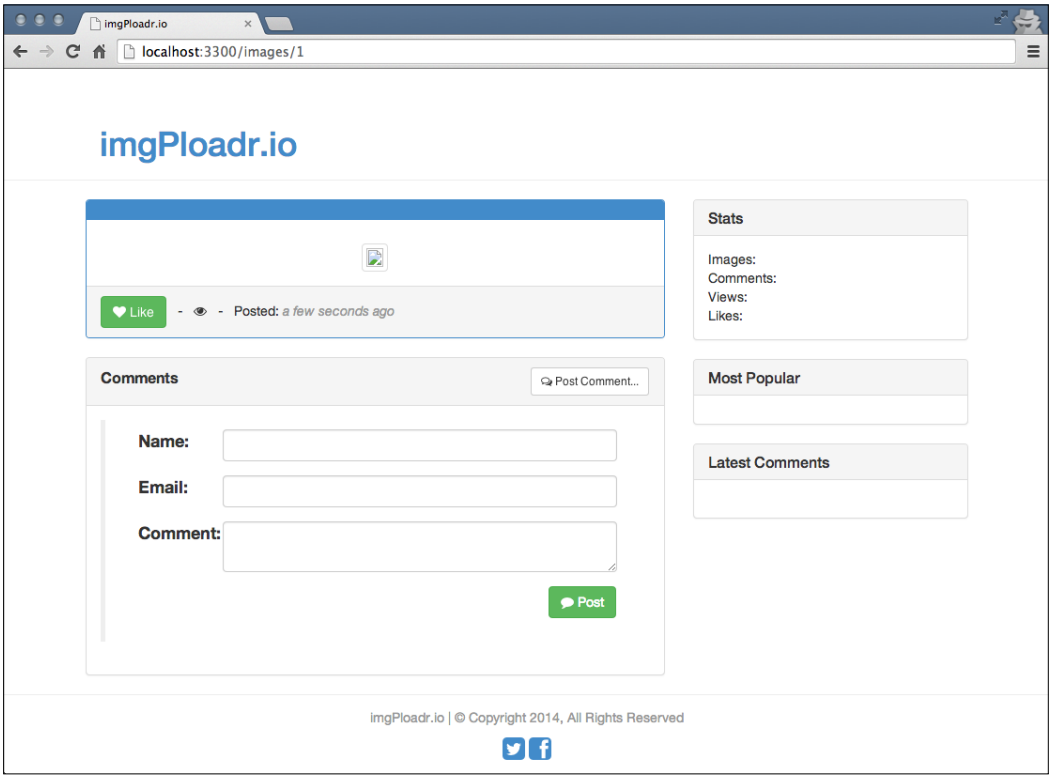
And that's it! Let's fire up the server and open the app in our browser and see how it looks:

```
$ npm start
$ open http://localhost:3300
$ open http://localhost:3300/images/1
```

Success! Hopefully, you see something that closely resembles the following screenshot of the home page:



Additionally, if you provide a random URL to a specific image, for example `http://localhost:3300/images/1`, you should see the following screenshot:



Summary

In this chapter, we introduced the Handlebars template-rendering engine and reviewed the syntax used when creating dynamic HTML pages. We created a main layout for our app as well as the home page and image page views. We included partial views for the sidebar in the layout and created a global Handlebars helper to display custom formatted dates.

Even though neither of the views is currently displaying any data (because we aren't passing in a ViewModel yet), you can see that things are starting to come along nicely! In the next chapter, we will wire up the actual logic in the controllers for each page as well as build up the ViewModel so that we start seeing some actual content on our screens.

6
Controllers and View Models

Up until this point, the controllers we wrote for our application have been extremely basic. They were started with a simple task of sending text responses to the client. In the previous chapter, we updated the controllers so that they render an HTML view and send the HTML code to the client (instead of simple text). The primary job of a controller is to act as the logic that makes all of the necessary decisions to properly render a response to the client. In our case, this means retrieving and/or generating the data necessary for a page to appear complete.

In this chapter, we will:

- Modify the controllers so that they generate a data model and pass it to a view
- Include logic to support uploading and to save image files
- Update the controllers to actually render dynamic HTML
- Include helpers for the partials that generate the website statistics
- Iterate on the UI to include improved usability via jQuery

Controllers

A controller is nothing more than an object that contains similar logic and functionality within our application. In our project, a controller is tied directly via its functions to a corresponding route. For every route that we create in our router, two parameters are necessary. The first parameter is the string for the route itself, that is `/images/:image_id`. The second parameter is a controller function that will be executed when that route is accessed. For any route that has to do with images, we rely on the images controller. Likewise, any route that has to do with the home page relies on the home controller, and so on and so forth.

The steps we will take to define our controllers in our app are purely organizational and based on a personal preference. We created our controllers as modules so that our router wasn't a big, long convoluted mess of spaghetti code! We could have just as easily kept all of the logic contained in our controllers as functions directly within the routes themselves, but this would have been an organizational mess and made for very hard-to-read code.

As our sample app is fairly small, we only have two controllers currently: `home` and `image`. It is the responsibility of these controllers to build the appropriate view models for our HTML pages and render the actual pages as well. Any logic that is required to execute per page and build the view model will be done so via our controllers.

View models

Given a single HTML view in our app, we need to be able to attach data to that page so that the template that is being rendered can be included in such a way that the dynamic areas of the page are replaced with real content. To do this, we need to generate a view model. During the render, the template engine will parse the template itself and look for special syntax that indicates that specific sections should be replaced at runtime with values from the view model itself. Think of this as a fancy runtime find and replace of your HTML templates—finding variables and replacing them with values stored in the view model sent to the template.

A view model, in the sense of how we are using one, is typically just a single JavaScript object (or collection of objects in an array) that can be passed to the template-rendering engine that contains all of the necessary data we need to properly render the page. The view model for a page will typically contain all of the data necessary to render the content-specific portions of that page. Using our application as an example, the view model for a specific image's page may contain the title of the image, its description, and the information necessary to display the image and various stats such as the number of likes, views, and a collection of comments. A view model can be as simple or as complex as you like.

Updating the home controller

If you take a look at our current home controller (`controllers/home.js`), you can see that the index function barely has any code in it whatsoever:

```
res.render('index');
```

The first thing we want to do is build a basic view model using sample data so that we can see our view model at work. Replace that single `res.render` call with the following updated code:

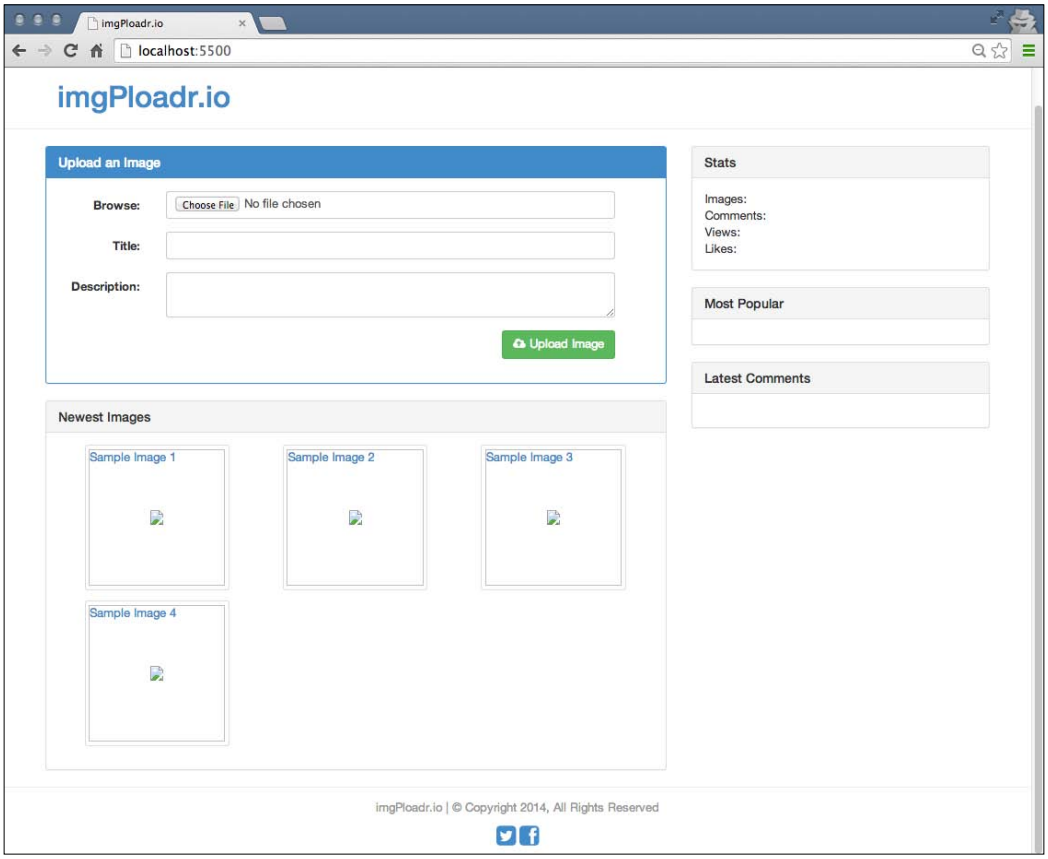
```
var viewModel = {
    images: [
        {
            uniqueId:       1,
            title:          'Sample Image 1',
            description:    '',
            filename:       'sample1.jpg',
            views:          0,
            likes:          0,
            timestamp:      Date.now
        }, {
            uniqueId:       2,
            title:          'Sample Image 2',
            description:    '',
            filename:       'sample2.jpg',
            views:          0,
            likes:          0,
            timestamp:      Date.now
        }, {
            uniqueId:       3,
            title:          'Sample Image 3',
            description:    '',
            filename:       'sample3.jpg',
            views:          0,
            likes:          0,
            timestamp:      Date.now
        }, {
```

```
                uniqueId:       4,
                title:          'Sample Image 4',
                description:    '',
                filename:       'sample4.jpg',
                views:          0,
                likes:          0,
                timestamp:      Date.now
            }
        ]
    };

    res.render('index', viewModel);
```

In this code, we built a basic JavaScript collection of objects. The variable we declare is called `viewModel`, but the name of this variable doesn't actually matter and can be whatever you want. The `viewModel` variable is an object that contains a single property called `images`, which is itself an array. The `images` array contains four sample images, each with a few basic properties—the most obvious properties we came up with while deciding what kind of information we want per image. Each image in the collection has a `uniqueId`, `title`, `description`, `filename`, `views` and `likes` count, and a `timestamp` property.

Once we have set up our `viewModel`, we simply pass it as the second parameter to the `res.render` call. Doing this while rendering a view makes the data in it available to the view itself. Now, if you recall from some of the HTML code we wrote for the home `index.handlebars` view, we had a `{{#each images}}` loop that iterated through each image in the `images` collection of the view model passed to the template. Taking another look at our view model we created, it only has a single property named `images`. The HTML code inside the Handlebars loop will then specifically reference the `uniqueId`, `filename`, and `title` properties for each image in the `images` array.

Save the changes to the home controller, launch your app again, and point your browser to `http://localhost:3300`. You should see the four images that appear on the homepage now in the **Newest Images** section (although, as you can see in the following screenshot, the images are still broken, as we didn't actually create any image files):



The home page has a fairly simple controller and view model, and you may have noticed that the sidebar is still completely empty. We'll cover the sidebar a little later in this chapter.

Updating the image controller

Let's create the controller and view model for the image page. The controller for the image will be a little more complex, as we'll write the logic to handle uploading and saving of the image files via the form on the homepage.

Displaying an image

The `index` function in the image controller will look almost identical to the `index` function from the home controller. The only difference is that instead of generating an array of images, we will build a view model for a single image. However, the view model for this image will have a little more information than the one from the homepage, since we are building a page that renders a more detailed view of an image (versus the thumbnail collection on the homepage). The most noteworthy inclusion is that of a `comments` array for the image.

Taking another look at the original `index` function in our `controllers/image.js` file, we can see the simple existing `res.render` line of code:

```
res.render('image');
```

We want to replace this line with a view model and an updated `res.render` statement using the following code:

```
var viewModel = {
    image: {
        uniqueId:       1,
        title:          'Sample Image 1',
        description:    'This is a sample.',
        filename:       'sample1.jpg',
        views:          0,
        likes:          0,
        timestamp:      Date.now
    },
    comments: [
        {
```

```
                image_id:   1,
                email:      'test@testing.com',
                name:       'Test Tester',
                gravatar:   'http://lorempixel.com/75/75/animals/1',
                comment:    'This is a test comment...',
                timestamp:  Date.now()
            },{
                image_id:   1,
                email:      'test@testing.com',
                name:       'Test Tester',
                gravatar:   'http://lorempixel.com/75/75/animals/2',
                comment:    'Another followup comment!',
                timestamp:  Date.now()
            }
        ]
    };

    res.render('image', viewModel);
```

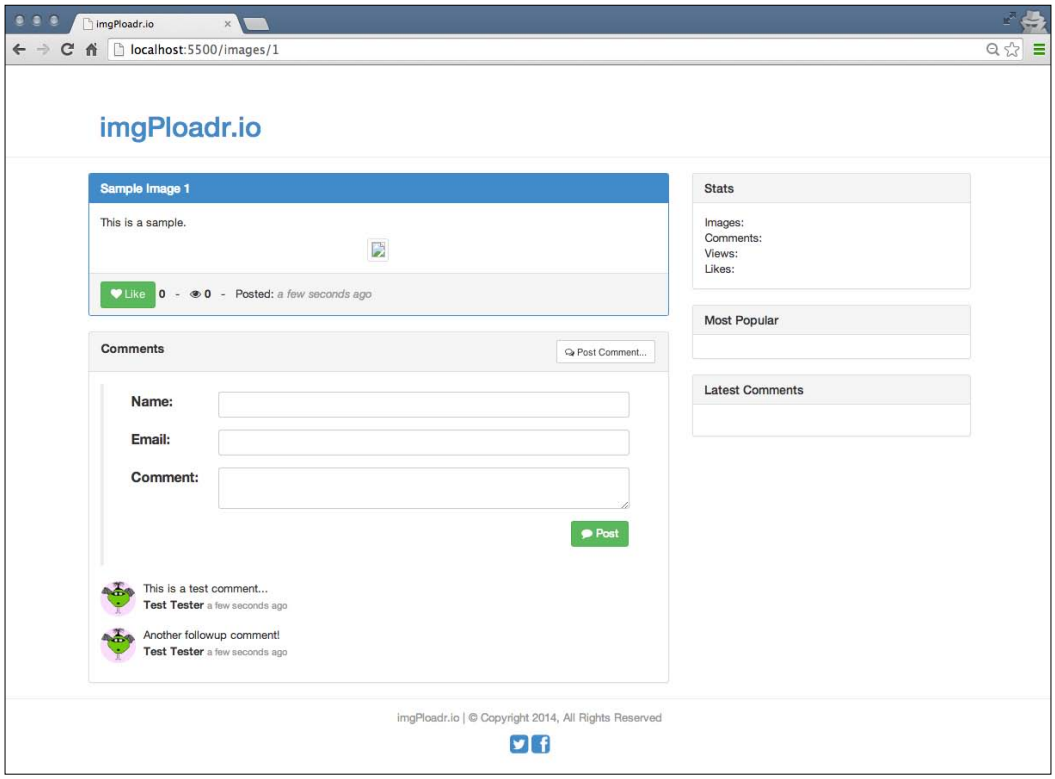
Here we are declaring a new `viewModel` variable again, this time with an `image` property that contains the properties for the single image. In addition to the `image` property, there is also a `comments` property, which is an array of `comment` objects. You can see that each comment has various properties specific to a comment for each image. This JavaScript object is actually a pretty good preview of what our real data will wind up looking like once we include logic to connect our app to MongoDB!

After we build our sample image object and its collection of comments, we pass that along to our `res.render` call, thus sending this new `viewModel` directly to our image's Handlebars template. Again, if you review the HTML code in the `image.handlebars` file, you can see where each property of the `viewModel` is being displayed.

Again, let's run the application and make sure our image page is appearing properly:

```
$ node server.js
```

Once the app is running and you've launched it in your browser, click on any of the images that are listed in the **Newest Images** section of the homepage. This should take you to an individual image page where you will see something like the page shown in the following screenshot:



Notice that the title, description, the likes and views count, and timestamp are all now appearing on the page. In addition, you can see a few comments listed below the image as well!

Uploading an image

The next feature we need to implement in our `image` controller is the logic to handle when a user submits an image via the **Image Upload** form on the homepage. Even though the form is on the homepage of our app, we decided to house the logic to handle uploading within our `image` controller because logically, this makes the most sense (since this feature has primarily to do with images and not the homepage per se). This was purely a personal decision, and you can house the logic wherever you please.

You should note that the HTML for the form on the homepage has its `action` set to `/images` and its `method` is `post`. This matches perfectly with the route we set up previously, where we are listening for a post to the `/images` route and calling the image controller's `create` function.

The `create` function in our image controller will have a few key responsibilities:

- It should generate a unique filename for the image, which will also act as an identifier
- It should save the uploaded file to the filesystem and ensure that it is an image file
- It should redirect to the `image/image_id` route once its task is complete to display the actual image

As we are going to be working with the filesystem in this function, we are going to need to include a few modules from the Node.js core set of modules, specifically the **File System** (`fs`) and the **Path** (`path`) modules.

Let's begin by first editing the `controllers/image.js` file and inserting the two new `require` statements at the very top of the file:

```
var fs = require('fs'),
    path = require('path');
```

Next, take the `create` function's original code:

```
res.send('The image:create POST controller');
res.redirect('/images/1');
```

Replace this original code with the following code:

```
var saveImage = function() {
    // to do...

};

saveImage();
```

Here, we created a function called `saveImage`, and we executed it immediately after we declared it. This might look a little odd, but the reason for this will become clearer when we implement database calls in the following chapter. The main reason is that we are going to call `saveImage` repeatedly to ensure that the unique identifier we generated is in fact unique and doesn't already exist in the database (as a previously saved image's identifier).

Let's review a breakdown of the code that will be inserted inside the `saveImage` function (replacing the `// to do...` comment). I will cover each line of code for this function and then give you the entire block of code at the end:

```
var possible = 'abcdefghijklmnopqrstuvwxyz0123456789',
    imgUrl = '';
```

We need to generate a random six-digit alphanumeric string to represent a unique identifier for an image. This identifier will work similar to other websites that provide tiny URLs for unique links (that is, `bit.ly`). To do this, we first provide a string of possible characters that can be used while generating the random string:

```
for(var i=0; i < 6; i+=1) {
    imgUrl += possible.charAt(Math.floor(Math.random() * possible.
length));
}
```

Then, loop six times and randomly pull out a single character from our string of possible characters, appending it in each cycle. By the end of this `for` loop, we should have a string that consists of six random letters and/or numbers, for example `'a8bd73'`:

```
var tempPath = req.files.file.path,
    ext = path.extname(req.files.file.name).toLowerCase(),
    targetPath = path.resolve('./public/upload/' + imgUrl + ext);
```

Here we declare three variables; where our uploaded files will be stored temporarily, the file extension of the file that was uploaded (that is '.png', '.jpg', and so on), and a destination where the uploaded image should ultimately reside. For both the latter variables, we use the `Path` node module, which works great while dealing with file names and paths and getting information from a file (such as a file extension). Next we move the image from its temporary upload path to its final destination:

```
if (ext === '.png' || ext === '.jpg' || ext === '.jpeg' || ext ===
'.gif') {
    fs.rename(tempPath, targetPath, function(err) {
        if (err) throw err;

        res.redirect('/images/99');
    });
} else {
    fs.unlink(tempPath, function () {
        if (err) throw err;

        res.json(500, {error: 'Only image files are allowed.'});
    });
}
```

This code performs some validation. Specifically, it conducts checks to make sure that the uploaded file extension matches a list of allowable extensions—namely, known image file types. If a valid image file was uploaded, it is moved from the `temp` folder via the filesystem's `rename` function. Notice how the filesystem (fs) `rename` function takes three parameters: the original file, the new file, and a callback function. The callback function is executed once the rename is complete. If node didn't work this way (always relying on callback functions), it's quite likely your code will execute immediately following the execution of the `rename` function and try to work against a file that doesn't exist yet (that is, the `rename` function didn't even finish doing its work). By using a callback function, we are effectively telling node that "once the rename of the file is finished and the file is ready and where it should be, then execute the following code."

The `else` condition that follows handles the situation when the uploaded file was invalid (that is, not an image), so we call the `unlink` function of the filesystem module, which will delete the original file (from the `temp` directory it was uploaded to) and then send a simple JSON 500 with an error message.

Here is the complete `saveImage` function (again, the following code will replace `// to do...` from earlier):

```
var possible = 'abcdefghijklmnopqrstuvwxyz0123456789',
    imgUrl = '';

for(var i=0; i < 6; i+=1) {
    imgUrl += possible.charAt(Math.floor(Math.random() * possible.
length));
}

var tempPath = req.files.file.path,
    ext = path.extname(req.files.file.name).toLowerCase(),
    targetPath = path.resolve('./public/upload/' + imgUrl + ext);

if (ext === '.png' || ext === '.jpg' || ext === '.jpeg' || ext ===
'.gif') {
    fs.rename(tempPath, targetPath, function(err) {
        if (err) throw err;

        res.redirect('/images/' + imgUrl);
    });
} else {
    fs.unlink(tempPath, function () {
        if (err) throw err;

        res.json(500, {error: 'Only image files are allowed.'});
    });
}
```

With this code in place, we can now successfully upload an image file via the form on the homepage. Give it a try by launching the app and opening it in a browser. Once there, click on the **Browse** button in the main form, and select an image file from your computer. If successful, the image file should exist within the `public/upload` folder of your project with a new random filename.

Be sure that you have the `public/upload/temp` folders created in your project, or you will get runtime errors when you attempt to write files to a location that doesn't exist. Write permissions may need to be set on the folder depending on your OS and security access.

After the upload form completes and the `create` controller function does its work, it will redirect to the individual image page for the image that was uploaded.

Helpers for reusable code

So far, each of the pages that we have rendered displays its `viewModel` data perfectly, but that pesky sidebar still remains blank. We're going to fix this by creating a few modules for the sidebar content but implementing them as helper modules. These helper modules are those that will be used repeatedly by various parts of our application and don't necessary belong to the `controller` folder or the `server` folder. So, we'll just create a new home called `helpers` and store these modules there.

As we are just loading temporary fixture data into our view models, the data we set up in the helpers as well as the controllers will all be replaced with actual live data in the next chapter once we implement MongoDB.

The sidebar module

First, we will create a module for the entire sidebar. This module will be responsible for calling multiple other modules to populate `viewModel` for each section of the sidebar. As we are going to be populating each page's own `viewModel` with data specifically for the sidebar, the `sidebar` module's function will accept that original `viewModel` as a parameter. This is so that we can append data to the existing `viewModel` for each page.

Here we will be appending a `sidebar` property (which is a JavaScript object) that contains properties for each of the sections of the sidebar.

To get started, first create a file named `helpers/sidebar.js` and insert the following code:

```
var Stats = require('./stats'),
    Images = require('./images'),
    Comments = require('./comments');

module.exports = function(viewModel, callback){
    viewModel.sidebar = {
        stats: Stats(),
        popular: Images.popular(),
        comments: Comments.newest()
    };

    callback(null, viewModel);
};
```

In the preceding code, you can see that we first required a module for each section of the sidebar. The existing `ViewModel` for any given page that displays the sidebar is the first parameter to the function. We add a `sidebar` property to `viewModel` and set values for each property by calling the module for each section of the sidebar. Finally, we execute a callback that was passed in as the second parameter to the `sidebar` module. This callback is an anonymous function that we will use to execute the rendering of the HTML page.

Let's update the `home` and `image` controllers to include a call to the `sidebar` module as well as defer rendering the HTML template for each page to the callback for the `sidebar` module.

Edit `controllers/home.js` and take the following line of code:

```
res.render('index', viewModel);
```

And replace it with this new block of code:

```
sidebar(viewModel, function(viewModel) {
    res.render('index', viewModel);
});
```

Make the exact same changes to the `controllers/image.js` file replacing `'index'` with `'image'`:

```
sidebar(viewModel, function(viewModel) {
    res.render('image', viewModel);
});
```

Again, notice how we are executing the `sidebar` module and passing the existing `viewModel` as the first parameter and a basic anonymous function as a callback for the second parameter. What this is doing is waiting to render the HTML for the view until after the sidebar has completed populating `viewModel`. This is because of the asynchronous nature of Node.js. Suppose we wrote the code in the following way instead:

```
sidebar(viewModel);
res.render('index', viewModel);
```

Here, it's quite likely that the `res.render` statement will execute before `sidebar` has even finished doing any work. This is going to become very important once we introduce MongoDB in the next chapter.

Additionally, as we are now using the `sidebar` module in each controller, be sure to require it at the top of both controllers by including the following code:

```
var sidebar = require('../helpers/sidebar');
```

Now that our `sidebar` module is complete, and it's being called from both controllers, let's finish the sidebar by creating each of the submodules that are required.

The stats module

The `stats` module is going to display a few random pieces of statistics about our app. Specifically, it will show the count for the total number of images, comments, views, and likes for the entire website.

Create the `helpers/stats.js` file and insert the following code:

```
module.exports = function() {
    var stats = {
        images:     0,
        comments:   0,
```

```
            views:      0,
            likes:      0
        };

        return stats;
    };
```

This module is pretty basic and all it does is create a standard JavaScript object with a few properties for the various stats, each set initially to `0`.

The images module

The `images` module is responsible for returning various collections of images. Initially, we will create a `popular` function that will be used to return a collection of the most popular images on the website. Initially, this collection will simply be an array of image objects with the sample fixture data present.

Create the `helpers/images.js` file and insert the following code:

```
module.exports = {
    popular: function() {
        var images = [
            {
                uniqueId:       1,
                title:          'Sample Image 1',
                description:    '',
                filename:       'sample1.jpg',
                views:          0,
                likes:          0,
                timestamp:      Date.now
            }, {
                uniqueId:       2,
                title:          'Sample Image 2',
                description:    '',
                filename:       'sample2.jpg',
                views:          0,
                likes:          0,
                timestamp:      Date.now
            }, {
                uniqueId:       3,
                title:          'Sample Image 3',
                description:    '',
```

```
                filename:       'sample3.jpg',
                views:          0,
                likes:          0,
                timestamp:      Date.now
            }, {
                uniqueId:       4,
                title:          'Sample Image 4',
                description:    '',
                filename:       'sample4.jpg',
                views:          0,
                likes:          0,
                timestamp:      Date.now
            }
        ];
        return images;
    }
};
```

The comments module

Similar to the images helper module, the `comments` module will return a collection of the newest comments posted to the site. The idea of particular interest is that each comment also has an image attached to it so that the actual image for each comment can be displayed as a thumbnail while displaying the list of comments (otherwise, we lose context when we see a random list of comments with no related image).

Create the `helpers/comments.js` file and insert the following code:

```
module.exports = {
    newest: function() {
        var comments = [
            {
                image_id:   1,
                email:      'test@testing.com',
                name:       'Test Tester',
                gravatar:   ' http://lorempixel.com/75/75/animals/1',
                comment:    'This is a test comment...',
                timestamp:  Date.now(),
                image: {
                    uniqueId:       1,
                    title:          'Sample Image 1',
                    description:    '',
```

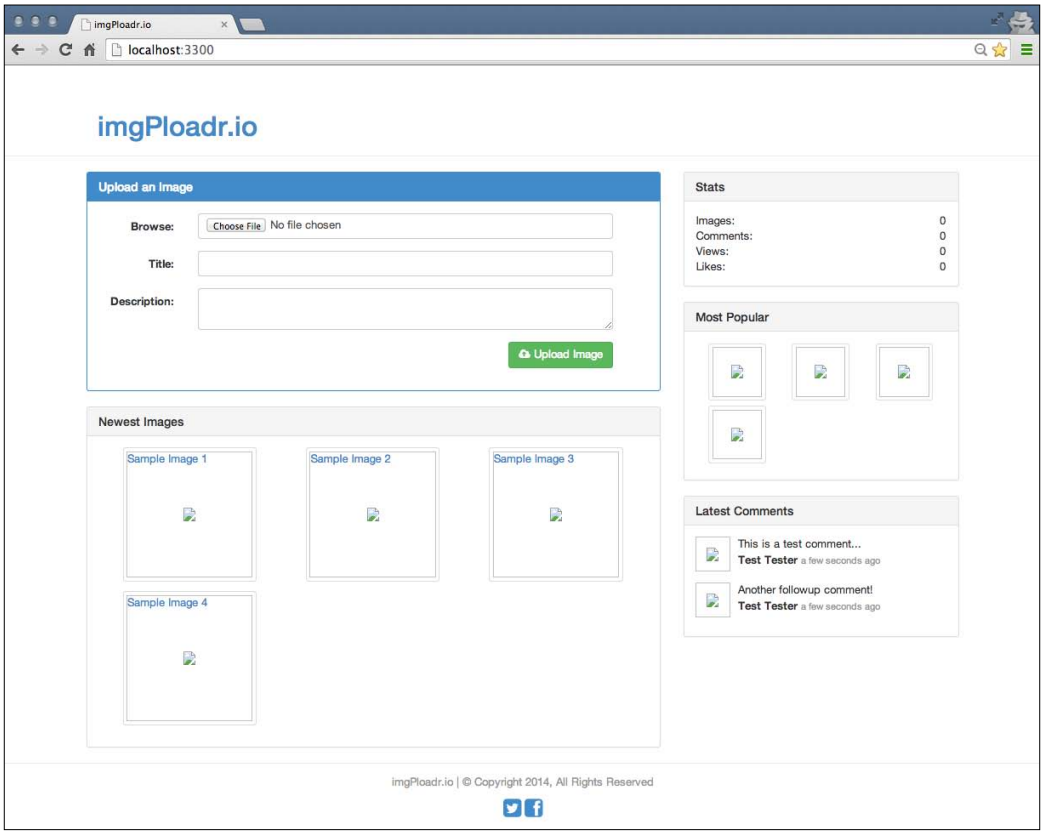
```
                    filename:       'sample1.jpg',
                    views:          0,
                    likes:          0,
                    timestamp:      Date.now
                }
            }, {
                image_id:   1,
                email:      'test@testing.com',
                name:       'Test Tester',
                gravatar:   'http://lorempixel.com/75/75/animals/2',
                comment:    'Another followup comment!',
                timestamp:  Date.now(),
                image: {
                    uniqueId:       1,
                    title:          'Sample Image 1',
                    description:    '',
                    filename:       'sample1.jpg',
                    views:          0,
                    likes:          0,
                    timestamp:      Date.now
                }
            }
        ];

        return comments;
    }
};
```

Again, this is just a basic JavaScript array of objects with a few properties for each comment, one of which is an actual image and its properties (the `image` property should look familiar since it's the same as one of the items in the `images` helper module).

Testing the sidebar implementation

Now that our `sidebar` module is complete along with its dependent submodules for the various stats, images, and comments, it's time to give our application another test run. Launch the node server and open the application in your browser.

You should now see the sidebar complete with content on both the homepage as well as the image page:



Iterating on the UI

Now that we have our application working fairly well and can actually interact with it, it's time to step back and take a look at some areas we may be able to improve.

One area is the **Post Comment** form on the image page. I don't think it's necessary that this form is always visible, but instead it should be made available only when someone actually wants to post a comment.

Additionally, I'd love the **Like** button to not have to post a full form submission to the server and cause the entire page to reload (like the form on the homepage does when it uploads an image). We will use jQuery to submit an AJAX call to the server to handle the likes, and send and retrieve data in real time without ever reloading the page!

To make these tweaks, we're going to need to introduce a small amount of JavaScript on the page to add a little interactivity. To make things even easier, we'll use the popular jQuery JavaScript library to make creating interactive features like these a breeze.

jQuery has been around for a number of years and has been explosively popular in frontend development. Simply put, jQuery is JavaScript with training wheels. It allows you to manipulate the **Document Object Model** (**DOM**—the HTML structure of any page) extremely easily as you will see in the next section. You can learn more about jQuery at `http://jquery.com`.

You may not have noticed, but in the HTML code that was provided for the `main.handlebars` layout file, jQuery has already been included as an external script tag (referencing jQuery hosted on a CDN). Additionally, a local `scripts.js` tag is also included, where we will put our custom jQuery JavaScript code for the changes we're going to make to the UI. When you look at the very bottom of `main.handlebars`, you can see the following code:

```
<script src="//ajax.googleapis.com/ajax/libs/jquery/1.11.0/jquery.min.
js"></script>
<script type="text/javascript" src="/public/js/scripts.js"></script>
```

The first script tag points to Google's Code **Content Delivery Network** (**CDN**), which means we don't have to worry about hosting that file with our code. The second file, however, is our own file, so we are going to need to make sure that exists.

CDN is a means of delivering a file from a globally distributed network of caching servers. What this means, generally speaking, is that files that are very commonly downloaded by web visitors (such as jQuery for example) can be loaded much quicker via a regionally closer download source as well as improved caching. If multiple websites use the same CDN URL to host jQuery, for example, it stands to reason that a visitor to your website may have already downloaded jQuery from visiting a previous unrelated website. Therefore, your website will load that much quicker!

Create the `public/js/scripts.js` file and insert the following code:

```
$(function(){
    // to do...
});
```

This is a standard code block that you'll see almost every time anyone uses jQuery. What this code does is execute an anonymous function within the `$()` jQuery wrapper, which is shorthand for writing the following code:

```
$(document).ready(function(){
  // to do...
});
```

This code basically just means that the callback function will wait until the page is fully loaded and ready before executing. This is important because we don't want to apply UI event handlers and/or effects to DOM elements that don't actually exist yet because the page is still loading. This is also another reason why the script tags in the `main.handlebars` layout file are the last lines of the page; so, they are the last to load ensuring that the document has already been fully downloaded and is ready to be manipulated.

First, let's address the **Post Comment** functionality. We want to hide the comment form by default, and then display it only when a user clicks on the **Post Comment** button below an image (to the right of the **Like** button). Insert the following code inside the callback function where the `// to do...` comment exists:

```
$('#post-comment').hide();
$('#btn-comment').on('click', function(event) {
    event.preventDefault();

    $('#post-comment').show();
});
```

The first line of code executes the `hide` function on the HTML div that has a `'post-comment'` ID. We then immediately apply an event handler to the HTML button with a `'btn-comment'` ID. The event handler we apply is for `onClick` because we want it to execute the anonymous function we provided whenever a user clicks on that button. That function simply prevents the default behavior (the default behavior for that particular element; in this case, a button) and then calls the `show` jQuery function, which reveals the `'post-comment'` div that was previously hidden. The `event.preventDefault()` part is important because if we didn't include that, the action of clicking on the button would do what a browser expects it to do *and* try to execute our custom JavaScript function at the same time. If we didn't include this, it's likely that our UI will behave in ways that are less than ideal. A good example is if you want to override the default behavior of a standard HTML link, you can assign an `onClick` event handler and do whatever you want. However, if you don't perform `event.preventDefault()`, the browser is going to send the user to the HREF for that link, regardless of what your code is trying to do.

Now let's add some code to handle the **Like** button functionality. We are going to want to add an event handler for the button, the same way we did for the **Post Comment** button, using jQuery's `.on` function. After the code that you added previously, insert this additional block of code:

```
$('#btn-like').on('click', function(event) {
    event.preventDefault();

    var imgId = $(this).data('id');

    $.post('/images/' + imgId + '/like').done(function(data) {
        $('.likes-count').text(data.likes);
    });
});
```

The preceding code attaches an `onClick` event handler to the `'btn-like'` button. The event handler first retrieves the `data-id` attribute from the **Like** button itself (assigned via the `image.handlebars` HTML template code and the `viewModel`) and then performs a jQuery AJAX `POST` to the `/images/:image_id/like` route. Recall the following line from our Node `server/routes.js` file:

```
app.post('/images/:image_id/like', image.like);
```

Once that AJAX call is `done`, another anonymous callback function will be executed that will change the text of the HTML element with a `likes-count` class and replace it with the data that was returned from the AJAX call—in this case, the updated total count of likes (typically, it would be whatever it was previously plus one).

In order to test this functionality, we are going to need to implement some fixture data in our `like` function inside the image controller. Edit `controllers/image.js` and within the `like` function, replace the existing `res.send` function call with the following code:

```
like: function(req, res) {
    res.json({likes: 1});
},
```

All this code does is return JSON to the client with a simple object that contains a single `likes` property with a value of `1`. In the next chapter, when we introduce MongoDB to the app, we'll update this code to actually increment the count of likes and return the true value for the liked image.

With all of those changes in place, you should be able to re-launch the node server and open the website in your browser. Click on any image on the homepage to view the image page and then click on the **Like** button to see it change from `0` to `1`. Don't forget to check out the fancy new **Post Comment** button too—clicking on this should reveal the comment form!

Summary

At the beginning of this chapter, we had some basic HTML pages that appear in a browser via our application, but they contained no content and no logic whatsoever. We implemented the logic for each of our controllers and learned about the view model and how to populate pages with content.

In addition to displaying content on our pages via a view model, we also implemented the code to handle uploading and saving image files to the local file system.

We tweaked the UI slightly to include some subtle enhancements using jQuery by revealing the comment form and used AJAX to track likes instead of a relying on a full-page postback.

Now that the groundwork has been laid for our view models and controllers, let's tie it all together using MongoDB and start working with real data. In the next chapter, we will update the controllers once again, this time implementing the logic to read from and save data to our MongoDB server.

7
Persisting Data with MongoDB

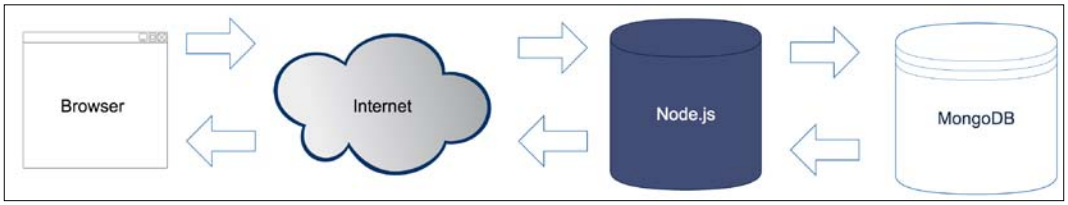
With almost any application written for the Web nowadays, a highly interactive application is of limited value if the interactions of its users aren't permanently saved. The most common way to handle this requirement is with a database that permanently saves data to the filesystem. Imagine a world where all of the data for your application (registered users, order transactions, and social interactions) were all stored within the temporary memory of the server the application is running on. The moment that server is turned off or rebooted, all of your application that would be lost. Relying on a database to store this data permanently is crucial to the success of any dynamic application.

In this chapter, the following topics will be covered:

- Connecting to MongoDB
- An introduction to Mongoose
- Schemas and models
- Adding CRUD to our controllers

In the previous chapter, we wrote and accounted for the actual logic of our application. The next step in building our application is to connect it to a database so that our users' interactions and data can be permanently saved and retrieved. Without connecting our application to a database server to persist data, every interaction by a visitor will be lost the second they left the page. Without some kind of database server to store our data, most of the websites we interact with on a daily basis wouldn't even exist. Technically, we can get around this by storing data in memory, but the moment our web server restarts or crashes, all of that data would be lost.

Here is a general breakdown of how our data is going to be persisted for every visitor interaction in our app:



Consider the previous diagram, which reflects the typical lifecycle of a web application request:

1. A visitor submits a request to view a page on our application via their web browser.
2. Our Node.js server receives this request and queries a MongoDB server for any data.
3. Our MongoDB server returns the queried data back to our Node.js server.
4. Our Node.js server takes that data and builds it into the view model and then sends the rendered HTML page back to the browser.
5. The web browser receives the response from our Node.js server and renders the HTML.
6. This cycle repeats typically for every interaction by every visitor.

For the purposes of this book, we are using MongoDB as our primary data store—but the reality is that we can use anything to store data: mySQL, postgreSQL, MS SQL, the filesystem, and so on.

Using MongoDB with Node

Before we officially implement MongoDB into our actual application, let's first take a look at some basic examples of connecting to a MongoDB server from within Node.js.

Create a new project folder to store some sample code to experiment with. I'll call my folder `mongotest`. Inside this folder, create a new file called `test.js` and in this file we will play around with some code to test how to connect to MongoDB and how to insert and retrieve some data. The first thing we need to do in order to connect to a MongoDB server from node is to require a `mongodb` module.

To get started, change directories into the new `mongotest` folder and install the `mongodb` module using npm:

```
$ cd mongotest
$ npm install mongodb
```

Don't be confused by the module's name. The `mongodb` npm module isn't MongoDB itself, but rather a third-party npm module that facilitates communicating to a MongoDB server from within Node.js. Also, because this is just a sample project to experiment with, we don't require the `--save` flag with `npm install` since we aren't maintaining a `package.json` file.

Connecting to MongoDB

Now that the `mongodb` module is installed, we can use it in our experimentation file. Boot up your editor, and create a file named `test.js`. Insert the following block of code into it:

```
var MongoClient = require('mongodb').MongoClient;

MongoClient.connect('mongodb://localhost:27017/mongotest',
function(err, db) {
    console.log('Connected to MongoDB!');

    db.close();
});
```

Executing the preceding code should log **Connected to MongoDB!** to your screen.

The first thing you'll notice is that we require the `mongodb` module, but we specifically use the `MongoClient` component of the module. This component is the actual interface we use to actively open a connection to a MongoDB server. Using `MongoClient`, we pass the `mongodb://localhost:27017/mongotest` string URL to our local server as the first parameter. Notice that the path in the URL points to the server and then the name of the database itself.

Remember to make sure you have your local MongoDB server instance running in another terminal for the duration of this chapter. To do so, open a command-line terminal window and execute `$ mongod`. Your server should launch and log information to the screen ending with **[initandlisten] waiting for connections on port 27017**.

You may find that when run your application, you receive a stack trace error with something like the following code:

```
events.js:72
        throw er; // Unhandled 'error' event
              ^
Error: failed to connect to [localhost:27017]
```

If this happens, you should recognize that it failed to connect to `localhost` on port `27017`—also known as the port that our local `mongod` server runs under by default.

Once we have an active connection to our database server, it's as if we are running the mongo shell command. The `MongoClient` callback function returns a database connection object (that we named `db` in our code, but could have been named anything), which is almost exactly the same object we work with in the mongo shell when we execute `use databasename`. Knowing this, at this point, we can use the `db` object to do anything we can do via the mongo shell. The syntax is slightly different, but the idea is generally the same.

Inserting a document

Let's test out our new `db` object by inserting a record into a collection:

```
var MongoClient = require('mongodb').MongoClient;

MongoClient.connect('mongodb://localhost:27017/mongotest',
function(err, db) {
    console.log('Connected to MongoDB!');

    // using the db connection object, save the collection 'testing'
to
    // a separate variable:
    var collection = db.collection('testing');
    // isert a new item using the collection's insert function:
    collection.insert({'title': 'Snowcrash'}, function(err, docs) {
        // on successful insertion, log to the screen the new
        // collection's details:
```

```
            console.log(docs.length + ' record inserted.');
            console.log(docs[0].title + ' - ' + docs[0]._id);
            // finally close the connection:
            db.close();
        });
    });
```

In the preceding code, we establish a connection to the database and execute a callback once the connection is complete. That callback receives two parameters, the second of which is the `db` object itself. Using the `db` object, we can get a collection we want to work with. In this case, we save that collection as a variable so that we can more easily work with it throughout the rest of our code. Using the `collection` variable, we execute a simple `insert` command and pass in the JSON object we want to insert into the database as the first parameter.

The callback function that executes after `insert` accepts two parameters, the second of which is an array of documents affected by the command; in this case, an array of documents that we inserted. Once `insert` is complete and we are inside the callback function, we log some data. You can see that the length of the `docs` array is `1` as we only inserted a single document. Furthermore, you can see that the single document in the array is the document we inserted, although now it has an extra `_id` field since MongoDB handles that automatically.

Retrieving a document

Let's prove our code a little bit more by adding a `findOne` call to look up the document we just inserted. Change the code in `test.js` to match the following example:

```
var MongoClient = require('mongodb').MongoClient;

MongoClient.connect('mongodb://localhost:27017/mongotest',
function(err, db) {
    console.log('Connected to MongoDB!');

    var collection = db.collection('testing');
    collection.insert({'title': 'Snowcrash'}, function(err, docs) {
        console.log(docs.length + ' record inserted.');
        console.log(docs[0]._id + ' - ' + docs[0].title);

        collection.findOne({title: 'Snowcrash'}, function(err, doc) {
            console.log(doc._id + ' - ' + doc.title);
            db.close();
        });
    });
});
```

In this code, we are inserting a record in exactly the same way as before; only this time, we are performing `findOne` on `title`. The `findOne` function accepts a JSON object to match against (this can be as precise or loose as you want) as its first parameter. The callback function that executes after `findOne` will contain the single document that was found as its second parameter. If we executed a `find` operation, we would have received an array of matching documents based on the search criteria.

The output of the last mentioned code should be:

```
$ node test.js
Connected to MongoDB!
1 record inserted.
538bc3c1a39448868f7013b4 - Snowcrash
538bc3c1a39448868f7013b4 - Snowcrash
```

In your output, you might notice that the `_id` parameter being reported on `insert` doesn't match the one from `findOne`. This is likely the result of running the code multiple times, which results in multiple records with the same title being inserted. The `findOne` function will return the first document found in no particular order, so chances are the document returned may not be the last one inserted.

Now that you have a basic understanding of how to easily connect and communicate with a MongoDB server from Node, let's take a look at how we can work with MongoDB in a way that's a little less raw.

Introducing Mongoose

While working directly with the `mongodb` module is great, it's also a bit raw and lacks any sense of developer friendliness that we've come to expect working with frameworks such as Express in Node.js. Mongoose is a great third-party framework that makes working with MongoDB a breeze. Mongoose is an elegant `mongodb` object modeling for Node.js.

What that basically means is that Mongoose gives us the power to organize our database by using schemas (also known as model definitions) and providing powerful features to our models such as validation, virtual properties, and more. Mongoose is a great tool as it makes working with collections and documents in MongoDB feel much more elegant. The original `mongodb` module is a dependency of Mongoose, so you can think of Mongoose as being a wrapper on top of `mongodb` much like Express is a wrapper on top of Node.js—both abstract away a lot of the "raw" feeling and give you easier tools to work with directly.

It's important to note that Mongoose is still MongoDB, so everything you're familiar with and used to will work pretty much the same way; only the syntax will change slightly. This means that the queries and inserts and updates that we know and love from MongoDB work perfectly fine with Mongoose.

Let's take a look at some of the features that Mongoose has to offer and what we'll take advantage of to make our lives easier when developing apps that heavily rely on a MongoDB database.

Schemas

In Mongoose, schemas are what we use to define our models. Think of them as a blueprint that all models you create throughout the app will derive from. Using schemas, you can define much more than the simple blueprint of a MongoDB model. You can also take advantage of the built-in validation that Mongoose provides by default, add static methods, virtual properties, and more!

The first thing we do while defining a schema for a model is build a list of every field we think we will need for a particular document. The fields are defined by type, and the standard datatypes you would expect are available as well as a few others:

- String
- Number
- Date
- Buffer
- Boolean
- Mixed: "Anything goes" field type. Consider this when storing JSON type data or data that is arbitrary and can literally be any JSON representation. It doesn't need to be predefined.
- ObjectId: Typically used when you want to store the ObjectID of another document in a field, for example when defining a relationships.
- Array: A collection of other schemas (that is, models).

Here is an example of a basic Mongoose Schema definition:

```
var mongoose = require('mongoose'),
    Schema = mongoose.Schema;

var Account = new Schema({
    username: { type: String },
```

```
    date_created: { type: Date, default: Date.now },
    visits: { type: Number, default: 0 },
    active: { type: Boolean, default: false }
});
```

Here we define our schema for an `Accounts` collection. The first thing we do is require `mongoose` and then define a schema object using `mongoose.Schema` in our module. We define a schema by creating a new `Schema` instance with a constructor object that defines the schema. Each field in the definition is a basic JavaScript object with `type`, and then an optional `default` value.

Models

A model in Mongoose is a class that can be instantiated (defined by a schema). Using schemas, we define models and then use them like a regular JavaScript object. The benefit is that the model object has the added bonus of being backed by Mongoose, so it also includes features such as saving, finding, creating, and removing. Let's take a look at defining a model using a schema and then instantiating a model and working with it.

The first thing we need to do is install Mongoose so that it's available to use within our `mongotest` project:

```
$ npm install mongoose
```

Continuing with editing our experimentation file, `mongotest/test.js`, include the following block of code after the existing code:

```
var mongoose = require('mongoose'),
    Schema = mongoose.Schema;

mongoose.connect('mongodb://localhost:27017/mongotest');
mongoose.connection.on('open', function() {
    console.log('Mongoose connected.');
});

var Account = new Schema({
    username: { type: String },
    date_created: { type: Date, default: Date.now },
    visits: { type: Number, default: 0 },
    active: { type: Boolean, default: false }
});
```

```
var AccountModel = mongoose.model('Account', Account);
var newUser = new AccountModel({  username: 'randomUser' });
console.log(newUser.username);
console.log(newUser.date_created);
console.log(newUser.visits);
console.log(newUser.active);
```

Running the preceding code should result in something similar to the following:

```
$ node test.js
randomUser
Mon Jun 02 2014 13:23:28 GMT-0400 (EDT)
0
false
```

Creating a `new` model is great when you're working with new documents and you want a way to create a new instance, populate its values, and then save it to the database:

```
var AccountModel = mongoose.model('Account', Account);
var newUser = new AccountModel({  username: 'randomUser' });
newUser.save();
```

Calling `.save` on a Mongoose model will trigger a command to MongoDB that will perform the necessary `insert` or `update` statements to update the server. When you switch over to your mongo shell, you can see the new user was indeed saved to the database:

```
> use mongotest
switched to db mongotest
> db.accounts.find()
{ "username" : "randomUser", "_id" : ObjectId("538cb4cafa7c430000070f66"), "active" : false, "visits" : 0, "date_created" : ISODate("2014-06-02T17:30:50.330Z"), "__v" : 0 }
```

Note that without calling `.save()` on the model, the changes to the model won't actually be persisted to the database. Working with Mongoose models in your node code is just that—code. You have to execute MongoDB functions on a model for any actual communication to occur with the database server.

You can use the `AccountModel` to perform a `find` operation and return an array of `AccountModel` objects based on some search criteria that retrieve results from the MongoDB database:

```
// assuming our collection has the following 4 records:
// { username: 'randomUser1', age: 21 }
// { username: 'randomUser2', age: 25 }
// { username: 'randomUser3', age: 18 }
// { username: 'randomUser4', age: 32 }

AccountModel.find({ age: { $gt : 18, $lt : 30} }, function(err,
accounts){
    console.log(accounts.length);    // => 2
    console.log(accounts[0].username);    // => randomUser1
    mongoose.connection.close();
});
```

Here we use the standard MongoDB `$gt` and `$lt` for the value of age when passing in our query parameter to `find` (that is, find any document where the age is above 18 and below 30). The callback function that executes after `find` references an `accounts` array, which is a collection of `AccountModel` objects returned from the query to MongoDB. As a general means of good housekeeping, we close the connection to the MongoDB server after we are finished.

Built-in validation

One of the core concepts of Mongoose is that it enforces a schema on top of a schema-less design such as MongoDB. In doing so, we gain a number of new features, including built-in validation. By default, every schema type has a built-in `required` validator available. Furthermore, numbers have both `min` and `max` validators and strings have `enumeration` and `matching` validators. Custom validators can also be defined via your schemas. Let's take a brief look at some validation added to our example schema from earlier:

```
var Account = new Schema({
    username: { type: String, required: true },
    date_created: { type: Date, default: Date.now },
    visits: { type: Number, default: 0 },
    active: { type: Boolean, default: false },
    age: { type: Number, required: true, min: 13, max: 120 }
});
```

The validation we added to our schema is that the `username` parameter is now required, and we included a new field called `age`, which is a number that must be between 13 and 120 (years). If either value doesn't match the validation requirements (that is `username` is blank or `age` is less than 13 or greater than 120), an error will be thrown.

Validation will fire automatically whenever a model's `.save()` function is called; however, you can also manually validate by calling a model's `.validate()` function with a callback to handle the response. Building on the example, add the following code that will create a new `mongoose` model from the schema defined:

```
var AccountModel = mongoose.model('Account', Account);
var newUser = new AccountModel({  username: 'randomUser', age: 11 });
newUser.validate(function(err) {
    console.log(err);
});
// the same error would occur if we executed:
// newUser.save();
```

Running the preceding code should log the following error to the screen:

```
{ message: 'Validation failed',
  name: 'ValidationError',
  errors:
   { age:
      { message: 'Path 'age' (11) is less than minimum allowed value
(13).',
        name: 'ValidatorError',
        path: 'age',
        type: 'min',
        value: 11 } } }
```

You can see that the error object that is returned from `validate` is pretty useful and provides a lot of information that can help when validating your model and returning helpful error messages back to the user.

Validation is a very good example of why it's so important to always accept an error object as the first parameter to any callback function in Node. It's equally important that you check the error object and handle appropriately.

Static methods

Schemas are flexible enough so that you can easily add your own custom static methods to them, which then become available to all of your models that are defined by that schema. Static methods are great to add helper utilities and functions that you know you're going to want to use with most of your models. Let's take our simple age query from earlier and refactor it so that it's a static method and a little more flexible:

```
var Account = new Schema({
    username: { type: String },
    date_created: { type: Date, default: Date.now },
    visits: { type: Number, default: 0 },
    active: { type: Boolean, default: false },
    age: { type: Number, required: true, min: 13, max: 120 }
});

Account.statics.findByAgeRange = function(min, max, callback) {
    this.find({ age: { $gt : min, $lte : max} }, callback);
};


var AccountModel = mongoose.model('Account', Account);

AccountModel.findByAgeRange(18, 30, function(err, accounts){
    console.log(accounts.length);    // => 2
});
```

Static methods are pretty easy to implement and will make your models much more powerful once you start taking full advantage of them!

Virtual properties

Virtual properties are exactly what they sound like—fake properties that don't actually exist in your MongoDB documents, but you can fake them by combining other real properties. The most obvious example of a virtual property would be a field for full name, when only the first and last name are actual fields in the MongoDB collection. For the full name, you simply want to say, "return the model's first and last name combined as a single string and label it `fullname`":

```
// assuming the Account schema has firstname and lastname defined:

Account.virtual('fullname')
    .get(function() {
```

```
        return this.firstname + ' ' + this.lastname;
    })
    .set(function(fullname) {
        var parts = fullname.split(' ');
        this.firstname = parts[0];
        this.lastname = parts[1];
    });
```

Using the `virtual` function of a schema, we provide the name of the property as a string. Then, we call the `.get()` and `.set()` functions. It's not required to provide both, although it's fairly common. Sometimes, it may be impossible to provide `.set()` functionalities based on the nature of `.get()`.

In this example, our `get()` function simply performs basic string concatenation and returns a new value. Our `.set()` function performs the reverse—splitting a string on a space and assigning the models `firstname` and `lastname` field values with each result. You can see that the `.set()` implementation is a little flakey if someone attempts to set a model's `fullname` with a value of say, Dr. Kenneth Noisewater.

It's important to note that virtual properties are *not* persisted to MongoDB since they are not real fields in the document or collection.

There's a lot more you can do with Mongoose, and we only just barely scratched the surface. Fortunately, it has a fairly in-depth guide you can refer to at the following link:

`http://mongoosejs.com/docs/guide.html`

Definitely spend some time reviewing the Mongoose documentation so that you are familiar with all of the powerful tools and options available.

That concludes our introduction to Mongoose's models, schemas, and validation. Next up, let's dive back into our main application and write the schemas and models that we will be using to replace our existing sample `viewModels` as well as connecting with Mongoose.

Connecting with Mongoose

The act of connecting to a MongoDB server with Mongoose is almost identical to the method we used earlier when we used the `mongodb` module.

First, we need to ensure that Mongoose is installed. At this point, we are going to be using Mongoose in our main app, so we want to install it in the main project directory and also update the `package.json` file. Using your command-line terminal program, change locations to your `project` folder, and install Mongoose via npm, making sure to use the `--save` flag so that the `package.json` file is updated:

```
$ cd ~/projects/imgPloadr
$ npm install mongoose --save
```

With Mongoose installed and the `package.json` file updated for the project, we're ready to open a connection to our MongoDB server. For our app, we are going to open a connection to the MongoDB server once the app itself boots up and maintain an open connection to the database server for the duration of the app's lifetime. Let's edit the `server.js` file to include the connection code we need. First, include Mongoose in the app by requiring it at the very top of the file:

```
var express = require('express'),
    config = require('./server/configure'),
    app = express(),
    mongoose = require('mongoose');
```

Then, insert the following code right after the `app = config(app);` line:

```
mongoose.connect('mongodb://localhost/imgPloadr');
mongoose.connection.on('open', function() {
    console.log('Mongoose connected.');
});
```

That's it! Those few simple lines of code are all it takes to open a connection to a MongoDB server, and our app is ready to start communicating with the database. The only parameter we pass to the `connect` function of `mongoose` is a URL string to our locally running MongoDB server and a path to the collection we want to use. Then, we add an event listener to the `'open'` event of the `mongoose.connection` object and when that fires, we simply log an output message that the database server has connected.

Defining the schema and models

For the purposes of the application we are building, we're really only going to have two different unique schemas and associated models: an `image` model and `comment` model. If we were to take this application to production and really build it out with all of the necessary features, we should expect to have many more models as well.

First, create a new directory in your project labeled `models` and we will store the Node.js modules for each of our models here. Create three files in this directory named `image.js`, `comment.js`, and `index.js`. Let's take a look at the `image` model first. Copy the following block of code into the `models/image.js` file:

```
var mongoose = require('mongoose'),
    Schema = mongoose.Schema,
    path = require('path');

var ImageSchema = new Schema({
    title:          { type: String },
    description:    { type: String },
    filename:       { type: String },
    views:          { type: Number, 'default': 0 },
    likes:          { type: Number, 'default': 0 },
    timestamp:      { type: Date, 'default': Date.now }
});

ImageSchema.virtual('uniqueId')
    .get(function() {
        return this.filename.replace(path.extname(this.filename), '');
    });

module.exports = mongoose.model('Image', ImageSchema);
```

First, we define our `ImageSchema` with the various fields that we are going to want to store in MongoDB for each of the images. We created a virtual property of `uniqueid`, which is just the filename with the file extension removed. As we want our `Image` model to be available throughout the rest of our app, we export it using `module.exports`. Note that we are exporting the model not the schema (as the schema itself is fairly useless to us). Let's set up a similar model for comments. Copy the following block of code into the `models/comment.js` file:

```
var mongoose = require('mongoose'),
    Schema = mongoose.Schema,
    ObjectId = Schema.ObjectId;

var CommentSchema = new Schema({
    image_id:   { type: ObjectId },
    email:      { type: String },
    name:       { type: String },
    gravatar:   { type: String },
```

```
    comment:    { type: String },
    timestamp:  { type: Date, 'default': Date.now }
});

CommentSchema.virtual('image').set(function(image){
        this._image = image;
    }).get(function() {
        return this._image;
    });

module.exports = mongoose.model('Comment', CommentSchema);
```

There are a few important things to take note of with this model. First, we have a field labeled `image_id`, which has an `ObjectId` type. We're going to use this field to store the relationship between a comment and the image that it was posted to. The `ObjectId` that gets stored in this field is the `_id` of the related image document from MongoDB.

We also define `virtual` on the comment schema labeled `image`, which we provide a getter and setter for. The `image` virtual property will be how we attach the related image when we retrieve comments later in our controllers. For every comment, we are going to iterate through and look up its associated image and attach that image object as a property of the comment.

It's important to understand how Mongoose and MongoDB handle the naming of collections based on your schema and models. Typically, you name your models using singular terms, and Mongoose will recognize this and create your collections using a pluralized model name. So, a model defined as `Image` will have a collection in MongoDB named `images`. Likewise, a model named `Comment` will have a corresponding collection named `comments`. Mongoose tries to be smart about this; however, a model defined as `Person` will have a corresponding collection named `people` and so on. (And yes, octopus will result in octopi!)

Models index file

There's one last file in the models folder that we haven't yet touched on in our project. The `index.js` file within any folder in Node.js acts as an index file for the modules within it. This is by convention, so you don't have to adhere to this if you don't want to.

Since our `models` folder will contain a number of different files, each a unique module for one of our models, it would be nice if we could just include all of our models in a single require statement. Using the `index.js` file we can do so pretty easily too. Copy the following block of code into the `models/index.js` file:

```
module.exports = {
    'Image': require('./image'),
    'Comment': require('./comment')
};
```

The `index.js` file inside the `models` directory simply defines a JavaScript object that consists of a name-value pair for each module in our directory. We manually maintain this object, but this is the simplest implementation of the concept. Now, thanks to this basic file, we can perform `require('./models')` anywhere in our application and know that we have a dictionary of each of our models via that module. To reference a specific model in that module, we simply refer to the specific model as a property of the module. If we only wanted to require a specific model somewhere in our app instead, we can perform `require('./models/image')` just as easily! You will see more of this a little later and it will become much more clear.

Because our two models are so closely related, we are typically always going to require the models dictionary using `require('./models')` throughout our application.

Adding CRUD to the controllers

Now that our schemas are defined and our models are ready, we need to start actually using them throughout our application by updating our controllers with various CRUD methods where necessary.

CRUD stands for Create, Read, Update, and Delete.

Up until this point, our controllers have consisted of only fixture, or fake, data so we can prove that our controllers are working, and our view models were wired up to our templates. The next logical step in our development is to populate our view models with data directly from MongoDB. It would be even better if we could just pass our Mongoose models right to our templates as the `viewModel` itself!

The home controller

If you recall from the *Updating the Home controller* section of *Chapter 6, Controllers and View Models*, we originally created `viewModel` in our home controller that consisted of an array of JavaScript objects that were just placeholder fixture data:

```
var viewModel = {
    images: [
        {
            uniqueId:       1,
            title:          'Sample Image 1',
            description:    '',
            filename:       'sample1.jpg',
            views:          0,
            likes:          0,
            timestamp:      Date.now
        }, {
            uniqueId:       2,
            title:          'Sample Image 2',
            description:    '',
            filename:       'sample2.jpg',
            views:          0,
            likes:          0,
            timestamp:      Date.now
        }, {
            uniqueId:       3,
            title:          'Sample Image 3',
            description:    '',
            filename:       'sample3.jpg',
            views:          0,
            likes:          0,
            timestamp:      Date.now
        }, {
            uniqueId:       4,
            title:          'Sample Image 4',
            description:    '',
            filename:       'sample4.jpg',
            views:          0,
            likes:          0,
            timestamp:      Date.now
        }
    ]
};
```

We are going to replace that `viewModel` with a very stripped down version that we will then populate with real data from our mongoose models:

```
var viewModel = {
    images: []
};
```

Before we can populate that `viewModel` with real data, we need to first make sure our home controller can use our models. To do so, we must require the models module. Include this at the very top of the `controllers/home.js` file:

```
var sidebar = require('../helpers/sidebar'),
    ImageModel = require('../models').Image;
```

We could have required the full `models` module and have had access to both the `Comment` model as well as the `Image` model; however, for the homepage, we really only need to use the `Image` model. Now that our mongoose model for `Image` is available to our home controller, we can perform a `find` operation to retrieve a list of the newest images to display on the homepage. Replace the existing `sidebar()` call in your home controller with this updated version of the code:

```
ImageModel.find({}, {}, { sort: { timestamp: -1 }},
    function(err, images) {
        if (err) { throw err; }

        viewModel.images = images;
        sidebar(viewModel, function(viewModel) {
            res.render('index', viewModel);
        });
    });
```

Using `ImageModel`, we execute a MongoDB `find` query, but we provide no specifics for the actual query (a blank JavaScript object), which means it will return every document. The second parameter is also a blank JavaScript object, which means we aren't specifying how to map the results, so the full schema will be returned. The third parameter is an `options` object where we can specify things such as the sort field and order. In this particular query, we are retrieving every single image in the images collection sorted by timestamp in descending order (ascending order would have had a value of `1` instead of `-1`).

The callback function that executes after a successful find to the MongoDB database server will return both an error object as well as an `images` array of matching models; in our case, every image in the database. Using the array that's returned from the query, we simply attach it to our `viewModel` via its `images` property. Then, we call our `sidebar` function exactly as we did previously.

At this point, we are no longer populating our `viewModel` with fixture data but instead populating it with exactly what is returned from the database when we perform a basic `find` query using our mongoose `Image` model. The homepage for the application is officially data driven! Here is a recap of the entire `controllers/home.js` file:

```
var sidebar = require('../helpers/sidebar'),
    ImageModel = require('../models').Image;

module.exports = {
    index: function(req, res) {
        var viewModel = {
            images: {}
        };

        ImageModel.find({}, {}, { sort: { timestamp: -1 }},
            function(err, images) {
                if (err) { throw err; }

                viewModel.images = images;
                sidebar(viewModel, function(viewModel) {
                    res.render('index', viewModel);
                });
            });
    }
};
```

If you were to run the app and open it in a browser, you wouldn't actually see anything on the homepage. That's because we haven't actually inserted any data yet! That's coming up next. However, note that the page itself still works and you didn't get any errors. This is because MongoDB is simply returning an empty array from the find on `ImageModel`, which the Handlebars homepage template is handling fine because it's performing an `each` operation against an empty array so it's displaying zero images on the homepage.

The image controller

The image controller is by far the biggest component of our application. It contains most, if not all, of the logic that's powering our app. This includes displaying all of the details for an image, handling the uploading of images, and handling likes and comments. There's a lot to cover in this controller, so let's break it down by each section.

Index – retrieving an image model

The primary responsibility of the `index` function in our image controller is to retrieve the details for a single specific image and display that via its `viewModel`. In addition to the details for the actual image, the comments for an image are also displayed on the page in the form of a list. Whenever an image is viewed, we need to also update the views count for the image and increment it by one.

Begin by editing the `controllers/image.js` file and updating the list of required modules at the top to include our `models` module:

```
var fs = require('fs'),
    path = require('path'),
    sidebar = require('../helpers/sidebar'),
    Models = require('../models');
```

We also want to strip our `viewModel` down to its most basic form exactly as we did in the home controller. Replace the existing `viewModel` object variable with this new, lighter version:

```
var viewModel = {
    image: {},
    comments: []
};
```

After defining our blank `viewModel`, let's include a `find` call on the `Image` model so that we can look up an image specifically by its filename:

```
Models.Image.findOne({ filename: { $regex: req.params.image_id } },
    function(err, image) {
        if (err) { throw err; }
        if (image) {
            // to do...
        } else {
            res.redirect('/');
        }
    });
```

In the preceding code, we are using the `Models` module's `Image` model and performing `findOne`, which is identical to `find`, except it will only ever return a single document (matching or not) instead of an array as `find` returns. By convention, we use a singular variable name in our callback's second parameter versus a plural, just so we as developers can easily tell we are working with a single object or an array/collection of objects.

The query object we provide as the first parameter matches the `filename` field of an image document using MongoDB's `regex` filter and comparing to `req.params.image_id`, which is the value of the parameter in the URL as defined in our `routes` file. The URL for an image page will always be `http://localhost:3300/images/abcdefg`, where `abcdefg` will be the value of `req.params.image_id`. If you recall, we are randomly generating this value in the `create` function when an image is uploaded.

After checking to make sure our `err` object isn't null, we then check to make sure our `image` object is also not null. If it's not null, that means a model was returned from MongoDB; so, we found our image and we're good to go. If an `image` model wasn't returned because we tried searching for an image by a filename that doesn't exist, we simply redirect the user back to the homepage.

Let's now populate our `viewModel` by inserting the following lines in the area where we have the `// to do...` placeholder comment:

```
image.views = image.views + 1;
viewModel.image = image;
image.save();
```

We attach the image model that was returned from `findOne` to our `viewModel.image` property, but not before incrementing the `views` property of that model by `1` (so that we represent our actual plus one view as we load the page). Since we modified the model (by incrementing its views count), we need to ensure that it's saved back to MongoDB so we call the model's `save` function.

Now that `viewModel` has been updated with the image model and the views count has been incremented and saved, we next need to retrieve a list of comments associated with the image. Let's include a little bit more code to query the `Comment` model and find any comments that belong to the image. Insert the following block of code immediately after `image.save();` from earlier:

```
Models.Comment.find({ image_id: image._id}, {}, { sort: { 'timestamp':
1 }},
    function(err, comments){
        if (err) { throw err; }

        viewModel.comments = comments;

        sidebar(viewModel, function(viewModel) {
            res.render('image', viewModel);
        });
    }
);
```

Using `find` on our `Comment` model, we can pass in an object that contains our query as the first parameter; in this case, we are specifying that we want all comments where the `image_id` field is equal to the `_id` property of the main `image` model we attached to our `viewModel` earlier.

That code might look a little odd so let's elaborate. Remember that the `image` object that is returned from the original `Models.Image.findOne()` call is available throughout the entire scope of that callback function. No matter how deep we get nesting callback functions, we will always have access to that original `image` model. Therefore, we can access it and its properties inside the callback function that fires when our `Model.Comment.find()` has executed.

Once inside the `find` callback of `Comment`, we attach the `comments` array that was returned to our `viewModel` and then call our `sidebar` function exactly as we did previously when we first opened the controller and started editing this index function.

As a review, here is the entire `index` function inside the `controllers/image.js` file after it's been completely updated:

```
index: function(req, res) {
    // declare our empty viewModel variable object:
    var viewModel = {
        image: {},
        comments: []
    };

    // find the image by searching the filename matching the url
parameter:
    Models.Image.findOne({ filename: { $regex: req.params.image_id } }
},
        function(err, image) {
            if (err) { throw err; }
            if (image) {
                // if the image was found, increment its views counter
                image.views = image.views + 1;
                // save the image object to the viewModel:
                viewModel.image = image;
                // save the model (since it has been updated):
                image.save();

                // find any comments with the same image_id as the
image:
```

```
                Models.Comment.find({ image_id: image._id},{},{ sort:
{ 'timestamp': 1 }},
                    function(err, comments){
                        // save the comments collection to the
viewModel:
                        viewModel.comments = comments;
                        // build the sidebar sending along the
viewModel:
                        sidebar(viewModel, function(viewModel) {
                            // render the page view with its
viewModel:
                            res.render('image', viewModel);
                        });
                    }
                );
            } else {
                // if no image was found, simply go back to the
homepage:
                res.redirect('/');
            }
        });
},
```

Let's quickly recall all of the `index` controller's responsibilities and tasks:

1. Create a new empty `viewModel` object.
2. The `findOne` `image` model where the filename is a regex match to the URL `image_id` parameter.
3. Increment the found views of `image` by one.
4. Attach the found `image` model to `viewModel`.
5. Save the `image` model since its `views` has been updated.
6. Find all comments with the `image_id` property equal to the `_id` of the original `image` model.
7. Attach the array of found `comments` to `viewModel`.
8. Render the page using `sidebar` passing in the `viewModel` and callback function.

Create – inserting an image model

We already have the functionality in place in our `create` function to handle randomly naming and uploading an image file. Now we need to save that information to MongoDB for the uploaded image.

Let's update the original `saveImage` function inside `controllers/images.js:create` and include the functionality to tie it into the database.

Our goal with the `saveImage` function is two-fold. First, we want to make sure that we never save an image to the database with the same randomly generated filename as an already existing image. Second, we want to ensure that we only insert the image into the database after it has been successfully uploaded, renamed, and saved to the filesystem. We are going to make two modifications to the existing code to achieve this.

The first modification is to wrap the bulk of the logic with `find` against the randomly generated file name, and if any documents are returned from MongoDB as a match, we need to start the process over to repeat this as many times as necessary until we achieve a truly unique filename. The code to perform the search is as follows:

```
Models.Image.find({ filename: imgUrl }, function(err, images) {
    if (images.length > 0) {
        saveImage();
    } else {
        // do all the existing work...
    }
});
```

If an `images` array that is returned from `find` has a length greater than zero, it means at least one image was found to have the same filename as was generated with our random `for` loop. If that's the case, we want to call `saveImage` again which will repeat the whole process (randomly generate a new name, and perform a find on the database for that new name). We do this by previously defining the `saveImage` function as a variable so that within the `saveImage` function itself, we can execute it again by calling the original variable as the function.

A function that calls itself is called recursive.

Assuming no images were returned from `find`, it means we have generated a truly unique filename for our image and are safe to rename the file and upload it to the server as well as save a record to the database.

Originally, the last step of the `create` function was to redirect the visitor to the image's page within the callback that fired when the file system rename was finished. This is where we're going to want to create a new mongoose image model. We should redirect only when the database server is finished saving the image (again relying on a callback function). Consider the following line in the original function:

```
res.redirect('/images/' + imgUrl);
```

Replace this with this new block of code:

```
var newImg = new Models.Image({
    title: req.body.title,
    description: req.body.description,
    filename: imgUrl + ext
});
newImg.save(function(err, image) {
    console.log('Successfully inserted image: ' + image.filename);
    res.redirect('/images/' + image.uniqueId);
});
```

Here we create a brand new `Image` model and pass in the default values via its constructor. The `title` and `description` fields get set right from the values passed in via the HTML form using `req.body` and the form field names (`.title` and `.description`). The `filename` is what we build the same way we did originally when we set its destination for renaming it, except we don't include the path and directory names, just the randomly generated filename and the image's original extension.

We call the model's `.save()` function (just as we did earlier when we updated the image's `views` property in the `index` controller function). The `save` function accepts a second parameter in its callback, which will be the updated version of itself. Once the save is completed, and the image has been inserted into the MongoDB database, we then redirect to the image's page. The reason the callback returns the updated version of itself is because MongoDB will automatically include additional information such as `_id`.

As a review and sanity check, here is the complete code for the `saveImage` function in `controllers/image.js:create` with the new lines of code clearly highlighted:

```
var saveImage = function() {
    var possible = 'abcdefghijklmnopqrstuvwxyz0123456789',
        imgUrl = '';
    for(var i=0; i < 6; i+=1) {
        imgUrl += possible.charAt(Math.floor(Math.random() * possible.
length));
    }
```

```
    /* Start new code: */
    // search for an image with the same filename by performing a
find:
    Models.Image.find({ filename: imgUrl }, function(err, images) {
        if (images.length > 0) {
            // if a matching image was found, try again (start over):
            saveImage();
        } else {
    /* end new code:   */
            var tempPath = req.files.file.path,
                ext = path.extname(req.files.file.name).toLowerCase(),
                targetPath = path.resolve('./public/upload/' + imgUrl
+ ext);

            if (ext === '.png' || ext === '.jpg' || ext === '.jpeg' ||
ext === '.gif') {
                fs.rename(tempPath, targetPath, function(err) {
                    if (err) { throw err; }

                    /* Start new code: */
                  // create a new Image model, populate its details:
                    var newImg = new Models.Image({
                       title: req.body.title,
                       filename: imgUrl + ext,
                       description: req.body.description
                    });
                    // and save the new Image
                    newImg.save(function(err, image) {
                        res.redirect('/images/' + image.uniqueId);
                    });
                    /* End new code:   */
                });
            } else {
                fs.unlink(tempPath, function () {
                    if (err) { throw err; }

                    res.json(500, {error: 'Only image files are
allowed.'});
                });
            }
/* Start new code: */
        }
    });
/* End new code:   */
};

saveImage();
```

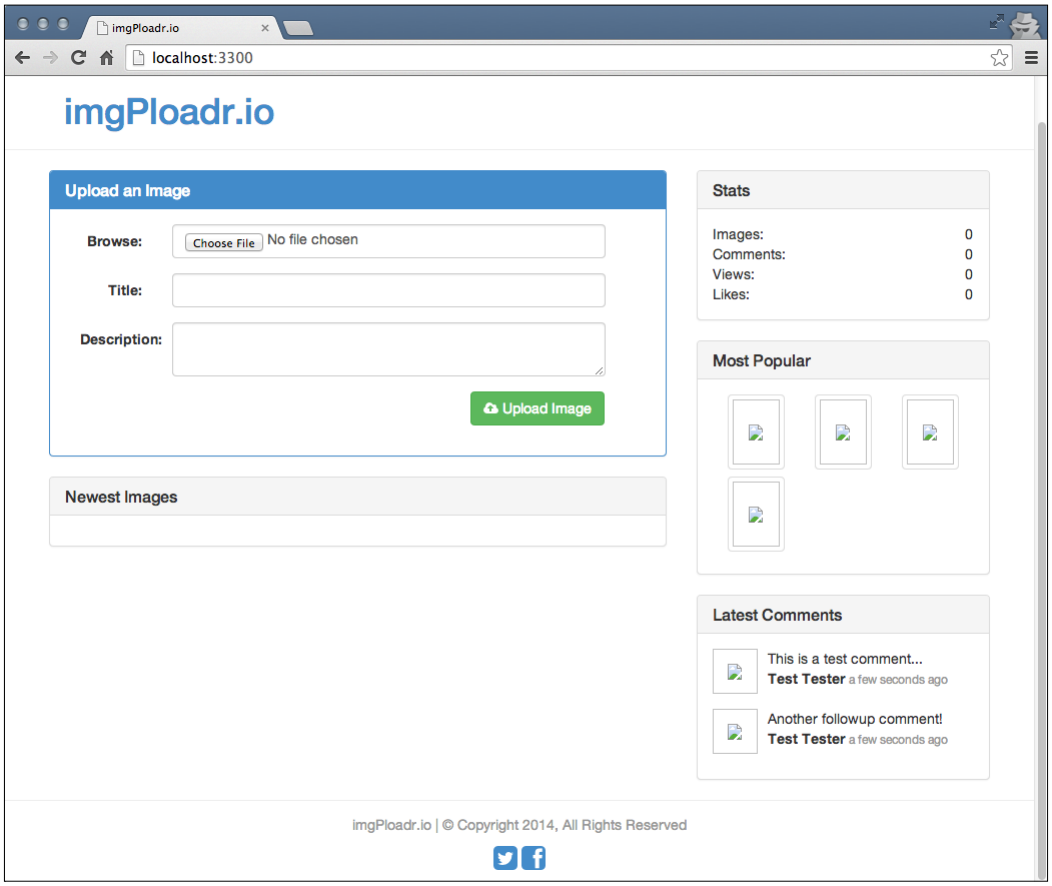
Don't forget to initially execute `saveImage()` right after the function is defined; otherwise, nothing will happen!

Testing everything out so far

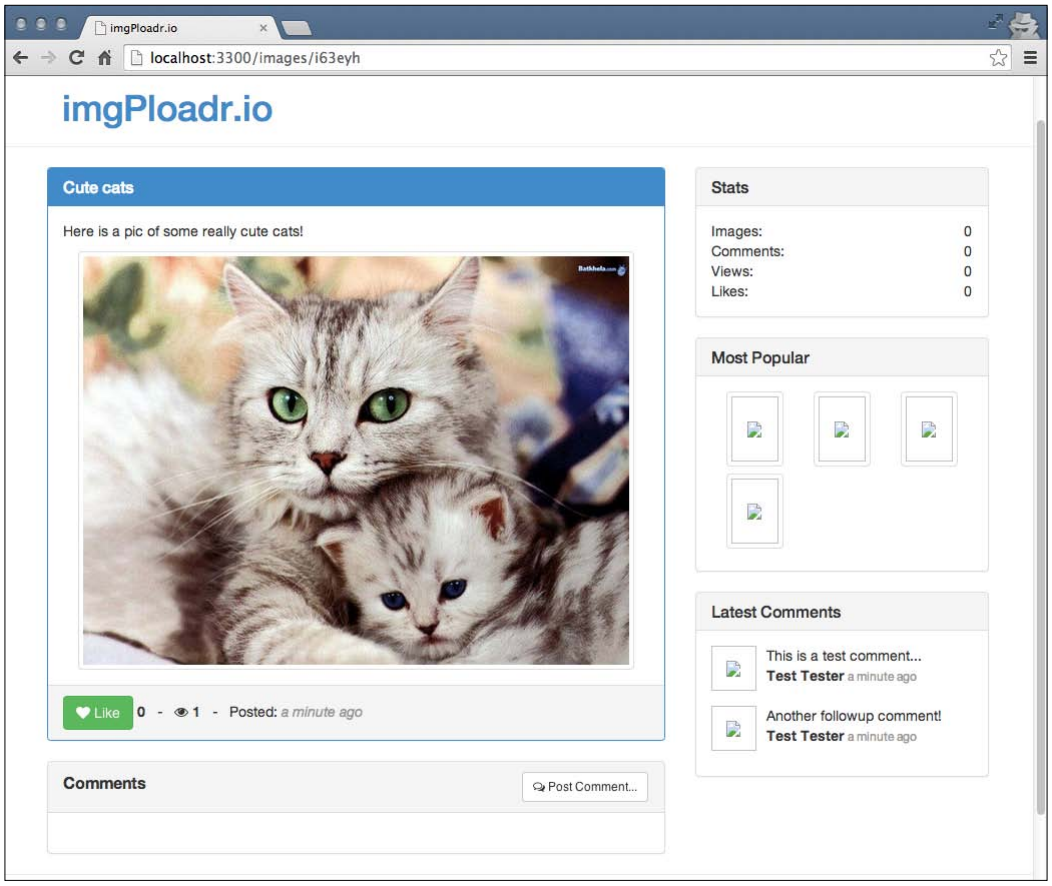
At this point, we have most of the key functionalities wrapped with MongoDB integration, and our app should really feel like it's coming together. Let's give it a test run and make sure all of our end points are working so far. Launch the app and open it in a browser:

```
$ node server.js
Server up: http://localhost:3300
Mongoose connected.
```

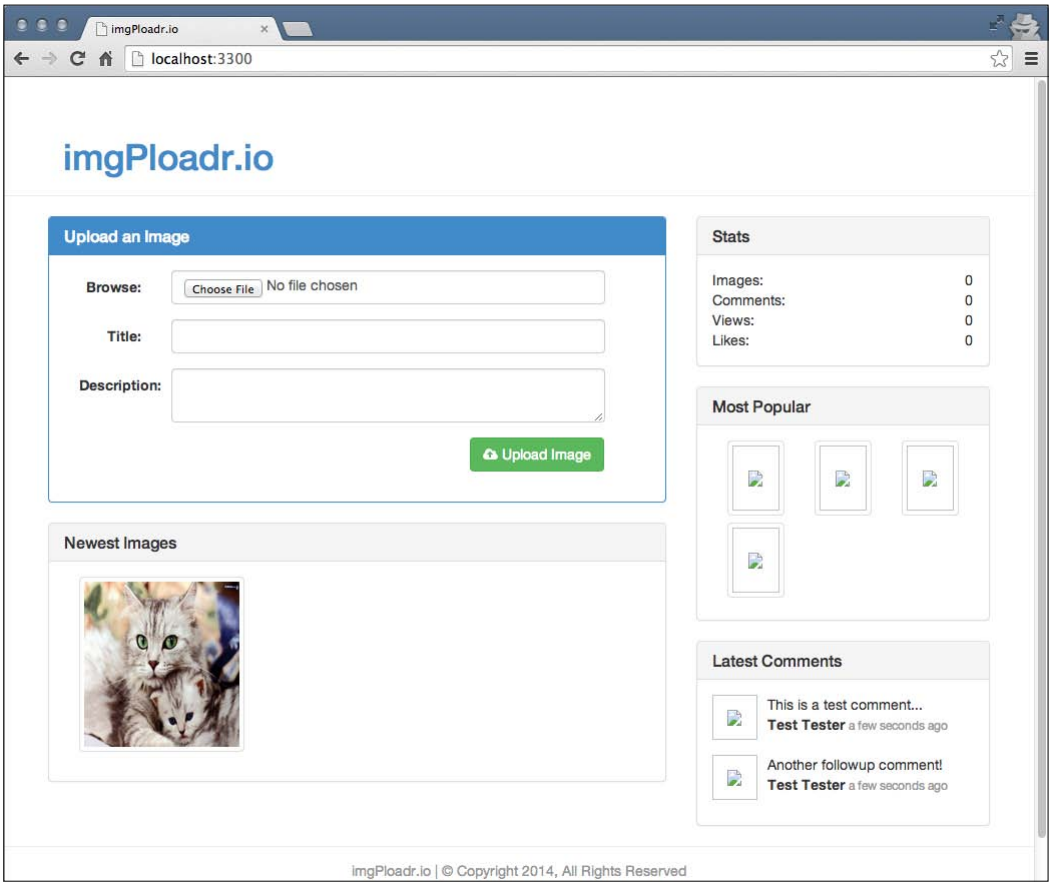
Open up a browser and point it to `http://localhost:3300`, and you should see your application up and running as in the following screenshot:



Go ahead and use the form on the homepage to browse for an image file on your computer and select it. Provide a title and description and click on the **Upload** button. You should be taken directly to the image page with the details for your uploaded image displayed:



Go back to the homepage, and you should now see your new image displayed under the **Newest Images** section:



Like – updating an image model

Next, let's add support for the **Like** button. Remember that our **Like** button works a little differently. It uses AJAX with jQuery so that data can be sent and received in real time without reloading the entire page. The experience for the user is seamless and enjoyable, as they don't lose their scroll place on the page or any other jarring UI-related issues.

The endpoint that the **Like** button hits is `/images/:image_id/like`, so we are going to use the value in the URL for `image_id` to find and retrieve the image in MongoDB, increment its `likes` value by `1`, and then return the new total number of `likes` for the image (so that the UI can update with the new value).

Currently, the `like` function in `controllers/image.js` only does a simple JSON response with a hardcoded value of `1`:

```
res.json({likes: 1});
```

Let's replace that original code with new code that will use the mongoose `Image` model to find an image with a filename that matches `image_id` passed in via the URL:

```
Models.Image.findOne({ filename: { $regex: req.params.image_id } },
    function(err, image) {
        if (!err && image) {
            image.likes = image.likes + 1;
            image.save(function(err) {
                if (err) {
                    res.json(err);
                } else {
                    res.json({ likes: image.likes });
                }
            });
        }
    });
```

Assuming the callback function receives a valid image model response from the query, we'll then increment its `likes` property, and since the model is then modified, we need to execute its `save` function. Inside the `save` function's callback, we send a JSON response back to the browser with the real current value of the image's `likes`.

Sometimes we will use shorthand in JavaScript and perform the following:

```
if (!err && image)
```

What this is actually doing is checking for falsey and truthy conditions, meaning the absence of `err` (or when its value is null) is treated as false. Any value that's not null, not '' (empty string), not `0`, or negative will be considered `True`. In the `if` statement in the preceding example, we are saying "if the `err` object is `false` (that is `null`) and the image object is true (that is not `null`), then we're good to go!"

With this code in place, you can run the app again and test out the **Like** button by viewing the image that you uploaded earlier and simply clicking on **Like**. If it worked, the counter next to the button should increase by one. Refresh the page, and the likes count should remain as the new value.

Comment – inserting a comment model

Inserting comments will work almost exactly the same way as the likes for an image. The only difference is that we are creating a new `comment` model instead of updating an `image` model. The original code we had in our comment function was:

```
res.send('The image:comment POST controller');
```

Let's replace this with some code that will find the image by the `image_id` in the URL again, but this time instead of updating its likes, we are going to create a new comment and assign the comment's `image_id` value with the `_id` of the image we are currently viewing (this is to attach a relationship to the comment so that it actually belongs to an image). Replace the entire comment function in `controllers/image.js` with the following block of code:

```
Models.Image.findOne({ filename: { $regex: req.params.image_id } },
    function(err, image) {
        if (!err && image) {
            var newComment = new Models.Comment(req.body);
            newComment.gravatar = md5(newComment.email);
            newComment.image_id = image._id;
            newComment.save(function(err, comment) {
                if (err) { throw err; }

                res.redirect('/images/' + image.uniqueId + '#' +
comment._id);
            });
        } else {
            res.redirect('/');
        }
    });
```

Here you can see that we are using the same code from the `like` function to query MongoDB and find the image with the matching filename from the URL.

Assuming a valid image is returned as a match, we create a new comment object called `newComment` and actually pass in the entire HTML form body into the constructor. This is a bit of a cheat as it's a coincidence (not accidental) that our HTML form uses form fields that have the same name and structure as that of a comment model. If you were to perform the `console.log` operation on the `req.body` object, you would see something like the following:

```
{
    name: 'Jason Krol',
    email: 'jason@kroltech.com',
    comment: 'This is what a comment looks like?!'
}
```

That's identical to what we would have just built manually anyway, so we just take a shortcut and pass the whole thing in as is! After that, we update a few more properties on the `newComment` model. First, we manually set a property called `gravatar`, which is where we will store the MD5 hash value of the commenter's email address so we can retrieve their Gravatar profile picture. Gravatar is a universal avatar service that stores profile pictures based on a user's e-mail address. However, the unique ID they use for each profile is an MD5 hash value, which is why we have to store that value.

As we are relying on the third-party MD5 module, we need to ensure that it's installed in our project and saved to our `package.json` file as a dependency. From your project's root folder, execute the following command:

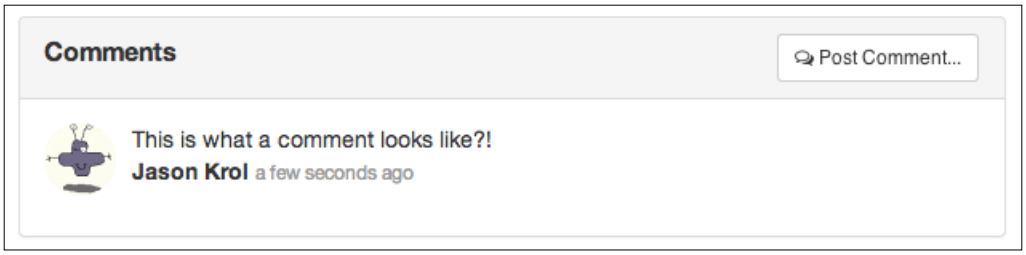
```
$ npm install MD5 --save
```

In addition, we need to require the module in the `controllers/image.js` file at the very top along with the other modules we are requiring:

```
var fs = require('fs'),
    path = require('path'),
    sidebar = require('../helpers/sidebar'),
    Models = require('../models'),
    MD5 = require('MD5');
```

Finally, we set the `image_id` property of the `newComment` to the `_id` property of the image we found at the beginning of the function. Then, we call the comment model's `.save()` function and redirect the user back to the image page. For convenience, we append a bookmark to the new comment's `_id` to the URL so that when the page loads it will automatically scroll down to the users' comments that have just been posted.

With that functionality in place, go ahead and fire up the app and open it in your browser. Visit the image page for any images you've uploaded and post a comment. Once the comment posts and the page reloads, you should see something like the following screenshot under an image:



We could have chosen to handle comments using jQuery and AJAX the same way we handled the **Like** button. However, this introduces a bit more complexity because if we were to do that, we would have needed a slightly more sophisticated way to display that inserted comment to the screen. This would have involved relying heavily on jQuery to do some advanced DOM manipulation to display the comment after it was posted using AJAX.

In a later chapter, when we review Single Page Applications, we will take a brief look at some JavaScript frameworks that perform this kind of functionality and a lot of other advanced features!

That concludes the code and functionality for the image controller.

Wrapping it up

Let's do a quick recap of all of the changes we've made to this controller:

1. Updated the `index` function to retrieve an image from MongoDB and populate `viewModel` with the details of the `image` model. We also found all comments related to that image and attached an array of those to `viewModel` as well.
2. We tweaked the `create` function to insert a new image model into the database once it has been successfully renamed and saved to the filesystem.
3. The `like` function was updated to actually increment the value of an image's `likes` property and save that value to the database as well as return the new value via a JSON response.
4. Comments are now inserted for a particular image via the `comment` function. Not only is a `comment` model inserted into the database, but also its corresponding image is found and the `image` model's `_id` value is attached to the comment to solidify a relationship.

Helpers

The last piece of the puzzle and last area we need to tie into MongoDB is the sidebar. To do this, we are going to need to update each of the helpers we previously created. Most of the helpers that we write code for are going to be using concepts and functionality that we've already covered in this chapter. However, there is the addition of one new concept that I want to focus on before we take a look at the code.

Introducing the async module

As JavaScript by its very nature is asynchronous, there undoubtedly comes a time when we need a way to handle executing a number of different asynchronous functions at the same time. The big issue here is that if we tried to perform three different queries to a MongoDB server for example, how will we know when all three are finished before we move on and do work with the results? Up until this point, we've simply been relying on a single callback function, which works great for a single call. How can we assign a single callback function to multiple asynchronous calls? The answer is we can't—not directly anyway. You can use a lot of nested callbacks to achieve this, but that is generally considered bad practice and will significantly reduce the readability of your code. We can use a third-party module, however, that was designed very specifically for this exact need.

`async` is a powerful node module that can be downloaded and installed via npm, which provides a number of extremely useful utility functions all designed to help when working with a series of asynchronous functions. Two functions that we are going to work with in this chapter are `series` and `parallel`. The `series` function allows us to execute asynchronous functions sequentially, each waiting until the previous function finishes before executing a single callback function at the end. The `parallel` function allows us to do the opposite—execute a number of asynchronous functions simultaneously, waiting until they all complete before executing a single callback function when the last function is finished. How does a single callback function handle the responses of a number of different asynchronous functions, you ask? By accepting an array of the responses of each function as a parameter!

Since we are going to be using async for our project, let's install it via npm and make sure our `package.json` file is updated as well. Within the root of your project folder, execute the following from the command line:

```
$ npm install --save async
```

The comments helper

Let's take a look at the first use of async in one of our helpers, the `comments` helper. Originally, `helpers/comments.js` was a module that had a `newest` function that returned an array of fixture data with some sample comments. We are going to completely remove this code and instead query MongoDB for the newest comments and return those as an array. Start by clearing the `comment` helper module and start from scratch (note that we included a new `callback` parameter to the `newest` function):

```
var models = require('../models'),
    async = require('async');
```

```
module.exports = {
    newest: function(callback) {
        // to do...
    }
};
```

Notice that we added the additional require statements at the top of the file for our models and async. Within the `newest` function, let's replace the `// to do...` comment with code to query MongoDB and find the five most recent comments:

```
models.Comment.find({}, {}, { limit: 5, sort: { 'timestamp': -1 } },
    function(err, comments){
        // to do - attach an image to each comment...
    });
```

Notice that the first parameter in the `find` query is an empty JavaScript object, meaning we will retrieve every comment in the database. For the third parameter, however, we're using `limit` and `sort` so that we limit the number of records returned to five, and we sort the query by `timestamp` in descending order.

Now that we have an array of comments, ideally, we'd like the image that each comment belongs to returned as well. Typically, this would be accomplished with an `aggregate` query in MongoDB to join different collections together (such as a JOIN in SQL). For the purposes of our code, we're going to instead query MongoDB separately for each comment and retrieve the image associated with the comment's `image_id` value.

First, let's define a function that will query MongoDB and retrieve and attach an `image` model to a `comment` model:

```
var attachImage = function(comment, next) {
    models.Image.findOne({ _id : comment.image_id},
        function(err, image) {
            if (err) throw err;
            comment.image = image;
            next(err);
        });
};
```

This function will accept a `comment` model as the first parameter, and a callback function as the second parameter (named `next`). The `next` callback as the second parameter is important because it's the key to how `async` is able to function. Imagine that the `next` callback acts as a chain link. Since the same function is going to be called for every item in a collection, there needs to be a way to daisy chain the calls together. This is performed via the callback.

Basically, every time the callback is called for an item in the array, it performs its work and then executes the same callback with the next item in the array, and so on and so forth, which is why we named the callback function parameter `next`.

Another important element to point out with this function is that when we attach the `image` model to the comments `image` property, we are using the virtual property we set up earlier in the main comment's schema. If you recall, when we set the `image` property, we are actually setting the private `_image` property. Likewise, when we get the `image` property, we are actually retrieving the private `_image` property.

After we have defined the `attachImage` function, we need to use the `each` function of `async` to apply that function to every item in the comments collection:

```
async.each(comments, attachImage,
    function(err) {
        if (err) throw err;
        callback(err, comments);
    });
```

The `each` function of `async` will loop through every item in the collection in the first parameter, and send each item as a parameter to a callback function in the second parameter. The third parameter is the final callback function that is executed once the entire series is finished with the collection. In this case, every comment in the comments array will be passed individually to the `attachImage` function. When the entire collection has been iterated through, the final callback will execute, which basically fires the very first `callback` function that was passed into the `newest` function as its only parameter. Boy that was a mouthful! Let's try to break this down a little further so it makes a bit more sense:

- The `newest` function of the comment helper module accepts a single parameter named `callback`—this is the function that will get called once all of the work is finished in this entire function.
- The first thing the `newest` function does is find the latest five comments and returns them as an array to an anonymously defined inline function.
- First, we define a function and store it in a variable named `attachImage`.
- The `attachImage` function accepts two parameters, an individual comment model, and a callback function that we named `next`.
- The `attachImage` function will query MongoDB to find an image with an `_id` value that is the same as the `image_id` property of the `comment` that was passed into it as the first parameter.
- Once that image is found, it is attached to the comment via its `image` property and then the `next` callback function is executed.

- We use `async.each` to loop through every comment in the `comments` array that was passed as the first parameter to `each`.
- Pass the `attachImage` function as the second parameter, which is the function that will be called for every comment in the comments array.
- Finally, define an inline anonymous function that will be executed once the last item in the comments collection has been iterated on. This inline function itself only accepts an error object as its parameter. Assuming every iteration of the `comments` collection was successful, this function will be executed with no error. Inside this function, we execute the original function named `callback` that was the only parameter to the `newest` function, and `callback` is called with the newly updated comments array as its second parameter.

OK, the hardest part is over! You survived a crash course on the `async` module and came out, hopefully, unscathed! Just to be safe, here is the code for the `helpers/comments.js` module file in its entirety:

```
var models = require('../models'),
    async = require('async');

module.exports = {
    newest: function(callback) {
        models.Comment.find({}, {}, { limit: 5, sort: { 'timestamp':
-1 } },
            function(err, comments){
                var attachImage = function(comment, next) {
                    models.Image.findOne({ _id : comment.image_id},
                        function(err, image) {
                            if (err) throw err;

                            comment.image = image;
                            next(err);
                        });
                };

                async.each(comments, attachImage,
                    function(err) {
                        if (err) throw err;
                        callback(err, comments);
                    });
            });
    }
};
```

Callback, callback, callbacks everywhere!

At this point, it's probably getting a little confusing with the number of callbacks we've been dealing with. A part of the problem is the terminology we've been using. Any function that is passed as a parameter and only executed after certain conditions are met, typically as the end result of the original function, is referred to as a callback. The popular convention with JavaScript is to label a callback function in a parameter literally with the variable name `callback` so that it's obvious. This works great when you are reading code, but not so much when you are explaining code and referring to a function named `callback` that's also known as *the* callback!

The helper sidebar

OK! So, of course, there's a catch right!? Well, kind of. Since we introduced `async` in our comments helper module, we now need to introduce it in our sidebar helper. This is because of the simple fact that our comments helper is now really asynchronous, so anything that uses our comments module needs to deal with that. As our sidebar module currently stands, it's just expecting the comments helper module to return an array and do it instantly; so, it's not expecting to have to wait around for the actual data. Because of this, if we ran our code as is, our comments sidebar would remain blank (because the sidebar would have rendered the page before the MongoDB calls were even finished thinking within the comments module). Let's fix this by updating our sidebar helper module to use `async` as well.

First, let's edit the `helpers/sidebar.js` file and replace its entire contents with this slightly modified version that uses `async.parallel`:

```
var Stats = require('./stats'),
    Images = require('./images'),
    Comments = require('./comments'),
    async = require('async');

module.exports = function(viewModel, callback){
    async.parallel([
        function(next) {
            next(null, Stats());
        },
        function(next) {
            next(null, Images.popular());
        },
```

```
            function(next) {
                Comments.newest(next);
            }
        ], function(err, results){
            viewModel.sidebar = {
                stats: results[0],
                popular: results[1],
                comments: results[2]
            };

            callback(viewModel);
        });
    };
```

The first thing we did was make sure `async` was included as a required module at the top of the file. Inside the primary `exports` function, we basically wrapped our existing code and integrated it into `async.parallel` so that we can easily tweak it a little later as we update each section of the sidebar helpers. Since we've so far only completed the comments helper module, that's the only one that's actually been changed. The other `Stats` and `Images.popular` calls are being forcibly used with `async.parallel` even though it doesn't quite make sense to do that right now. It will once those two sections become more asynchronous in the next sections.

The `parallel` function of `async` works in a similar way to its `each` function that we used earlier. The main difference is that `parallel` isn't performing the same function in a loop through a collection, but is instead performing a series of unique functions all at the same time. If you look closely, you can see that the first parameter to `parallel` is actually an array, and each item in the array is a unique function. Every function in the array accepts a `next` callback parameter function, which is executed at the conclusion of each of the functions. The second parameter in the `next` callback is the result of the work that was performed within the function itself. In the case of `Stats` and `Images.popular`, those two functions simply return values instantly with no asynchronous calls to anything else, so we just expect the results to be returned by executing them directly.

However, as you can see with the `Comments.newest` section, we are passing in the next callback function as a parameter because we want its execution to be deferred until the last second (that is, until `Comments.newest` is completely done all of its work). Once that `next` callback function is called, it is passed the results of all of its work.

The last parameter to the `parallel` function is an inline function that accepts a results array as its second parameter. This array is a collection of each of the results that were returned from each of the functions in the array in the first parameter. You can see that when we build `viewModel` now, we are referring to indexes in the results array. The index order is the order that the functions were defined in the original array. We know that the first function was to retrieve `Stats`, the second function to retrieve `Images.popular`, and the third function to retrieve `Comments.newest`. So, we can reliably assign `results[0]` to `viewModel.Stats`, and so on. As a reference, here is what the `viewModel` definition originally looked like in the sidebar module:

```
viewModel.sidebar = {
    stats: Stats(),
    popular: Images.popular(),
    comments: Comments.newest()
};
```

You can compare this with the updated version that uses `async`:

```
viewModel.sidebar = {
    stats: results[0],
    popular: results[1],
    comments: results[2]
};
```

Now that the sidebar is set up to properly handle the helper modules that are (and eventually will be) asynchronous, we can run the application and test to ensure our sidebar is properly displaying the top five most recent comments to the website. Run the application and launch it in a browser. If you haven't already posted any comments to an image, do so now so that you can see those comments appearing in the sidebar along with a thumbnail of the image they belong to.

Troubleshooting

At this point, we've covered and implemented a large number of changes to our application. It's understandable that something might be broken for you, so let's run through a quick checklist to make sure we haven't missed any trouble spots that might be preventing your app from running properly:

- Make sure you've npm installed all of the required modules for this chapter and that they are saved to your `package.json` file. This includes mongoose, async, and MD5.
- Make sure the appropriate dependency modules are being `required` at the top of each of the module files they are used in.

- Make sure you remember to launch `mongod` in another terminal instance whenever you run the application.
- When it doubt, pay attention to the stack trace output that node is giving you in your terminal when it fails, as it is typically pretty obvious what's wrong. It will also give you the filename and line number of the offending module.
- When all else fails, `console.log` everywhere!

Next up, let's update the helper stats module to use parallel as well so we can get some real stats for the application.

The stats helper

The primary responsibility of the stats helper module is to gather up some totals for our application. These stats are for things such as total number of images uploaded, total number of comments, total views for all images combined, and total likes for all images combined. Your first inclination might be to assume that we are going to query MongoDB for all images and loop through every image to track all of the views and totals. That's one way to do it, but it's pretty inefficient. Fortunately, MongoDB has some built-in functionalities that makes generating these kinds of values a snap.

As we are going to be making a number of calls to MongoDB, we are going to rely on the `async.parallel` function again much like we did in the sidebar module. The original `helpers/stats.js` file was very bare bones, so let's completely replace that file with this new version that uses parallel:

```
var models = require('../models'),
    async = require('async');

module.exports = function(callback) {
    async.parallel([
        function(next) {
             next(null, 0);
        },
        function(next) {
             next(null, 0);
        },
        function(next) {
             next(null, 0);
        },
        function(next) {
             next(null, 0);
        }
```

```
        ], function(err, results){
            callback(null, {
                images:   results[0],
                comments: results[1],
                views:    results[2],
                likes:    results[3]
            });
        });
    };
```

This code does exactly what the module originally did; only it's a little more verbose! I'm pretty sure we don't want to just return `0` for all of our stats forever though as that'd be pretty useless and unimpressive to say the least! Let's update each function to properly query MongoDB and get some stats. Looking at the object returned in the callback in the last function, we could see that we already defined the order of the functions that are executing in parallel. Let's start with images. Replace the `next(null, 0);` line in the first function with the following code snippet:

```
models.Image.count({}, next);
```

Easy! Just use MongoDB's count method to find the total number of documents in the images collection matching any criteria (the first parameter). Then, we just pass the `next` function as the callback because coincidentally enough the parameter signatures match. If we didn't want to use shorthand here, we could have written this the long way as:

```
models.Image.count({}, function(err, total){
    next(err, total);
});
```

However, who feels like typing all that when you don't have to! Let's do the same thing for the second function in the parallel array for total comments. Replace the `next(null, 0);` line in the second function with the following line of code:

```
models.Comment.count({}, next);
```

Again, piece of cake!

Now the next two functions are going to be a little different, but they are almost identical to each other. What we want to do with `next` is get the total views and likes for every image. We can't use MongoDB's count because that only counts individual documents in a collection. We need to use MongoDB's aggregate functionality instead.

Using aggregates, we can perform a mathematical operation such as `$sum` to tally up results for us. Replace the `next(null, 0);` line in the third function with the following code snippet:

```
models.Image.aggregate({ $group : {
    _id : '1',
    viewsTotal : { $sum : '$views' }
}}, function(err, result) {
    var viewsTotal = 0;
    if (result.length > 0) {
        viewsTotal += result[0].viewsTotal;
    }
    next(null, viewsTotal);
});
```

Using MongoDB's aggregate function, we are telling MongoDB to group every document together and sum up all of their views into a single new field called `viewsTotal`. The resulting collection that is returned to the callback function is an array of documents with the `_id` and `viewsTotal` fields. In this case, the results array will only contain a single document with the grand total because we weren't that tricky with our aggregate functionality. If there aren't any images in the collection at all, we need to handle that and check accordingly. Finally, the next callback function is called with the actual value for `viewsTotal`.

Let's use the same exact functionality to total up the likes for all images. Replace the `next(null, 0);` line of code in the fourth and final function in `parallel` with the following code snippet:

```
models.Image.aggregate({ $group : {
    _id : '1',
    likesTotal : { $sum : '$likes' }
}}, function (err, result) {
    var likesTotal = 0;
    if (result.length > 0) {
        likesTotal += result[0].likesTotal;
    }
    next(null, likesTotal);
});
```

Now that the sidebar helper module has been updated and is complete with the `async.parallel` functionality, let's make a minor tweak back in our sidebar module to ensure we are calling the `Stats` module correctly so that it's properly asynchronous. The original line in `helpers/sidebar.js` was:

```
next(null, Stats());
```

Replace that line of code with this slightly different version:

```
Stats(next);
```

Last but not least, let's take care of the most popular helper module of the images sidebar.

The popular images helper

Again, the original `helpers/images.js` file was mostly filled with fixture data and placeholder code that's fairly useless. Let's replace the entire file with this new version that's actually pretty tame in comparison to all of the other helper modules:

```
var models = require('../models');

module.exports = {
    popular: function(callback) {
        models.Image.find({}, {}, { limit: 9, sort: { likes: -1 }},
            function(err, images) {
                if (err) throw err;

                callback(null, images);
            });
    }
};
```

At this point, that code should be pretty familiar to you by now. We just query MongoDB and find the top nine most liked images by sorting the images by total like count in descending order and limiting the results to nine documents.

Let's edit the `helpers/sidebar.js` file again to include the updated call to the `Images.popular` function. Consider the original code:

```
next(null, Images.popular());
```

Replace this with the following slightly newer version:

```
Images.popular(callback);
```

And now the sidebar is completely finished and completely dynamic. No more fixture data or placeholder variables anywhere. Running the application should yield a fully functional website with all of the features we set out to implement working perfectly! Give it a spin and make sure it's working correctly.

Iterating by adding an image removal capability

At this point, I think our application is pretty awesome, but there's something missing that's nagging me. During testing, I've been creating all kinds of new images and uploading them to the application but it's starting to get a bit cluttered and messy. It dawned on me that the most obvious thing that's missing is the ability to remove an image!

In reality, I left out this feature on purpose so that we could use this opportunity to incorporate a completely new set of functionality that touches almost every area of the application. This seemingly simple addition is actually going to require the following changes:

- Update `routes.js` to include a new route to handle `Delete` requests
- Update `controllers/image.js` to include a new function for the route

  This should not only remove the image from the database, but also delete the file and all related comments
- Update the `image.handlebars` HTML template to include a **Remove** button
- Update the `public/js/scripts.js` file with an AJAX handler for the **Remove** button

Adding a route

The first thing we need to update in order to add this new functionality is the main `routes` list. Here we will add a new endpoint that handles DELETEs and points to a function within the image controller. Edit the `server/routes.js` file and insert the following new line of code:

```
app.delete('/images/:image_id', image.remove);
```

Adding a controller handler

Now that we have added a new route, we need to create the controller function that it's using as its callback (`image.remove`). Edit `controllers/image.js` and add the following new function code after the existing `comment: function(req, res){}` operation (don't forget to add a trailing comma after the comment function since you are adding a new function):

```
remove: function(req, res) {
    Models.Image.findOne({ filename: { $regex: req.params.image_id }
},
```

```
        function(err, image) {
            if (err) { throw err; }

            fs.unlink(path.resolve('./public/upload/' + image.
filename),
                function(err) {
                    if (err) { throw err; }

                    Models.Comment.remove({ image_id: image._id},
                        function(err) {
                            image.remove(function(err) {
                                if (!err) {
                                    res.json(true);
                                } else {
                                    res.json(false);
                                }
                            });
                    });
            });
        });
}
```

This function performs four primary functions (and as such nests four layers deep with callbacks—we could have used `async`'s `series` method here to prevent the crazy amount of nesting). The first task is to find the image that is attempting to be removed. Once that image is found, the file associated with the image should be deleted. Next, find the comments associated with the image and remove those. Once they have finished being removed, the last step is to remove the image itself. Assuming all of that was a success, simply send a `true` Boolean JSON response back to the browser.

Updating the Handlebars image page template

Now that we have a route and controller function to support deleting an image, we need a way for the UI to send the request. The most obvious solution is to just add a **Delete** button somewhere on the page. Edit the `views/image.handlebars` file and after the existing HTML, where we had the **Like** button, we are going to add new HTML for a **Delete** button:

```
<div class="col-md-8">
    <button class="btn btn-success" id="btn-like" ...
    // existing HTML for Like button and misc details
</div>
```

```
<div class="col-md-4 text-right">
    <button class="btn btn-danger" id="btn-delete" data-id="{{ image.
uniqueId }}">
    <i class="fa fa-times"></i>
    </button>
</div>
```

Here we just include a new `div` that's set to four columns using Bootstrap and right aligned. The UI here is that the **Like** button and stats are the left-most portion of the row, and the **Delete** button (an X icon from Font Awesome) is all the way to the right of the same row (and red since we use Bootstrap's danger color class).

Updating the jQuery

Finally, we are going to tie it all together by implementing code similar to the **Like** button, where we send an AJAX delete to the server with the URL and the image ID when the button is clicked on. To be safe, we display a standard JavaScript confirmation dialog to ensure the button wasn't clicked by accident.

Assuming the server responds with a true value, we will turn the button green and change the icon to a checkmark with the word **Deleted!** in place. Edit `public/js/scripts.js` and insert the following block of code after the existing code (be sure to insert the new code inside the `$(function(){ ... });` jQuery function):

```
$('#btn-delete').on('click', function(event) {
    event.preventDefault();
    var $this = $(this);

    var remove = confirm('Are you sure you want to delete this
image?');
    if (remove) {
        var imgId = $(this).data('id');
        $.ajax({
            url: '/images/' + imgId,
            type: 'DELETE'
        }).done(function(result) {
            if (result) {
                $this.removeClass('btn-danger').addClass('btn-
success');
                $this.find('i').removeClass('fa-times').addClass('fa-
check');
```

```
                $this.append('<span> Deleted!</span>');
            }
        });
    }
});
```

Let's test out this brand new functionality by launching the application, loading it up in a browser, finding any image we no longer want, and viewing its image page. The **Delete** button should now show up in place.

Refactoring and improvements

At this point, the application that we've been building is pretty much complete! Before we iterate anymore on the project and continue to build it out and make it ready for production, we should probably consider some refactoring and/or general improvements. Some areas that I would personally take a look at to refactor and/or rewrite to improve the application's performance and overall sanity are as follows:

- I might rethink working directly with Models so much within the controllers and instead create a utility that I can wrap a lot of that noise and rely on more basic CRUD calls to my Models and only providing a callback to each. This is most visible in the image controller with `like`, `comment`, and `remove`.
- Validation! There is literally no validation in the project that we wrote and that's mostly for brevity. In reality, we should have included validation on any input fields a user interfaces with. Validation should be provided both on the frontend via jQuery or plain old vanilla JavaScript as well as on the backend with Node. The validation should protect from users submitting invalid and/or malicious code (that is XSS, or Cross-Site Scripting).
- User authentication! Right now, our application is open to general public, which means any visitor that comes along can upload images as well as delete them! It would be fairly simple to include a user authentication process within our application. Passport.js is a great third-party module to integrate user authentication into Node.js applications.
- Instead of attaching images to comments for the purposes of the sidebar (`newest` comments), we should consider creating a more robust aggregate query using MongoDB to retrieve a hybrid collection of comments that includes the image provided directly from MongoDB.

Summary

What a journey! This chapter was a monster but was also the last piece of the puzzle to complete our app and have a fully dynamic database driven Node.js app that uses MongoDB. Congratulations on making it this far and sticking with it! You're well on your way to being a true full-stack JavaScript developer.

In the next chapter, we'll step away from our application for a bit as we take a look at working with REST APIs using Node.js.

8
Creating a RESTful API

Now that your application is complete and ready for the world to see, you might start thinking of ways to make it more popular. What if you wanted to allow external systems with access rights to your data in a way that they could mass produce inserts to your website without the need for users to visit the actual website? One example that comes to mind almost immediately is suppose users of another website, say `www.facebook.com`, can upload an image to Facebook and have it automatically uploaded to your website as well; can this be done?

The only way to make a scenario like this even possible is by providing an API to your data and code that gives external developers access to a suite of tools that will allow them to perform actions without the need to interact with the actual web pages.

In this chapter, we will review the following topics:

- Introducing RESTful APIs
- Installing a few basic tools
- Creating a basic API server and sample JSON data
- Responding to `GET` requests
- Updating data with `POST` and `PUT`
- Removing data with `DELETE`
- Consuming external APIs from Node

What is an API?

An **Application Programming Interface** (**API**) is a set of tools that a computer system makes available that provides unrelated systems or software the ability to interact with each other. Typically, a developer uses an API when writing software that will interact with a closed, external, software system. The external software system provides an API as a standard set of tools that all developers can use. Many popular social networking sites provide developer's access to APIs to build tools to support those sites. The most obvious examples are Facebook and Twitter. Both have a robust API that provides developers with the ability to build plugins and work with data directly, without them being granted full access as a general security precaution.

As you will see with this chapter, providing your own API is not only fairly simple, but also it empowers you to provide your users with access to your data. You also have the added peace of mind knowing that you are in complete control over what level of access you can grant, what sets of data you can make read-only, as well as what data can be inserted and updated.

What is a RESTful API?

Representational State Transfer (**REST**) is a fancy way of saying CRUD over HTTP. What this means is when you use a REST API, you have a uniform means to create, read, and update data using simple HTTP URLs with a standard set of HTTP verbs. The most basic form of a REST API will accept one of the HTTP verbs at a URL and return some kind of data as a response.

Typically, a REST API `GET` request will always return some kind of data such as JSON, XML, HTML, or plain text. A `POST` or `PUT` request to a RESTful API URL will accept data to create or update. The URL for a RESTful API is known as an *endpoint*, and while working with these endpoints, it is typically said that you are *consuming* them. The standard HTTP verbs used while interfacing with REST APIs include:

- `GET`: This retrieves data
- `POST`: This submits data for a new record
- `PUT`: This submits data to update an existing record
- `PATCH`: This submits a date to update only specific parts of an existing record
- `DELETE`: This deletes a specific record

Typically, RESTful API endpoints are defined in a way that they mimic the data models and have semantic URLs that are somewhat representative of the data models. What this means is that to request a list of models, for example, you would access an API endpoint of `/models`. Likewise, to retrieve a specific model by its ID, you would include that in the endpoint URL via `/models/:Id`.

Some sample RESTful API endpoint URLs are as follows:

- `GET http://myapi.com/v1/accounts`: This returns a list of accounts
- `GET http://myapi.com/v1/accounts/1`: This returns a single account by `Id: 1`
- `POST http://myapi.com/v1/accounts`: This creates a new account (data submitted as a part of the request)
- `PUT http://myapi.com/v1/accounts/1`: This updates an existing account by `Id: 1` (data submitted as part of the request)
- `GET http://myapi.com/v1/accounts/1/orders`: This returns a list of orders for account `Id: 1`
- `GET http://myapi.com/v1/accounts/1/orders/21345`: This returns the details for a single order by `Order Id: 21345` for account `Id: 1`

It's not a requirement that the URL endpoints match this pattern; it's just common convention.

Introducing Postman REST Client

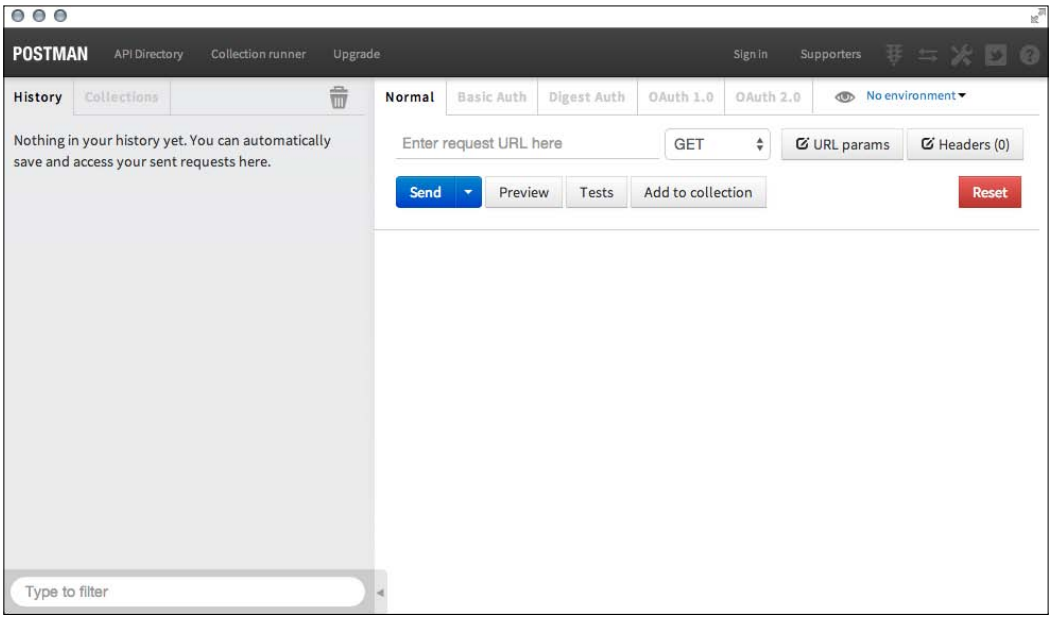
Before we get started, there are a few tools that will make life much easier when you're working directly with APIs. The first of these tools is called Postman REST Client, and it's a Google Chrome application that can run right in your browser or as a standalone-packaged application. Using this tool, you can easily make any kind of request to any endpoint you want. The tool provides many useful and powerful features that are very easy to use and, best of all, free!

Installation instructions

Postman REST Client can be installed in two different ways, but both require Google Chrome to be installed and running on your system. The easiest way to install the application is by visiting the Chrome Web Store at `https://chrome.google.com/webstore/category/apps`.

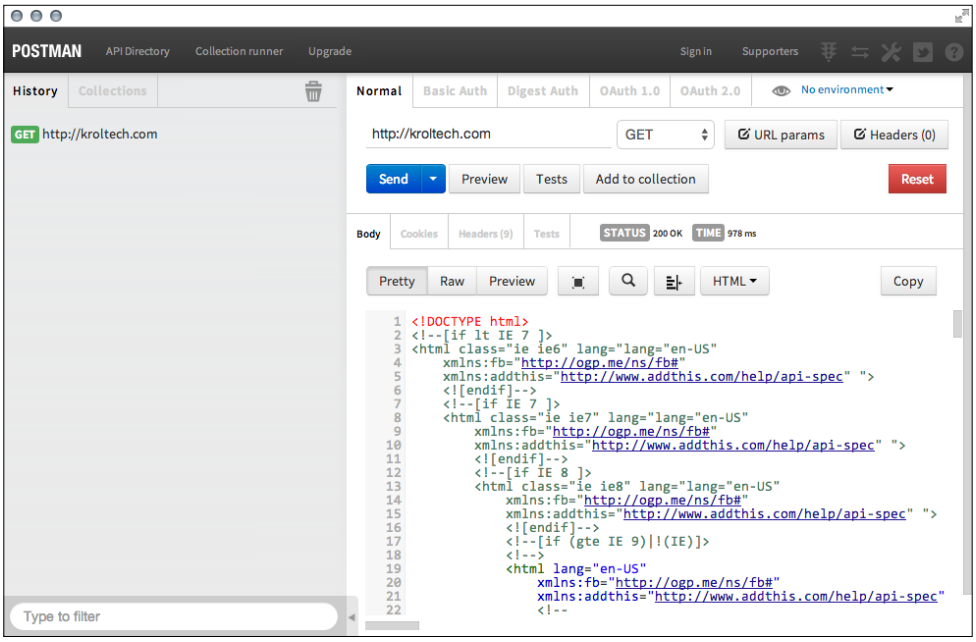
Perform a search for `Postman REST Client` and multiple results will be returned. There is the regular Postman REST Client that runs as an application built into your browser, and then separate Postman REST Client (packaged app) that runs as a standalone application on your system in its own dedicated window. Go ahead and install your preference. If you install the application as the standalone packaged app, an icon to launch it will be added to your dock or taskbar. If you installed it as a regular browser app, you can launch it by opening a new tab in Google Chrome and going to **Apps** and finding the Postman REST Client icon.

After you've installed and launched the app, you should be presented with an output similar to the following screenshot:

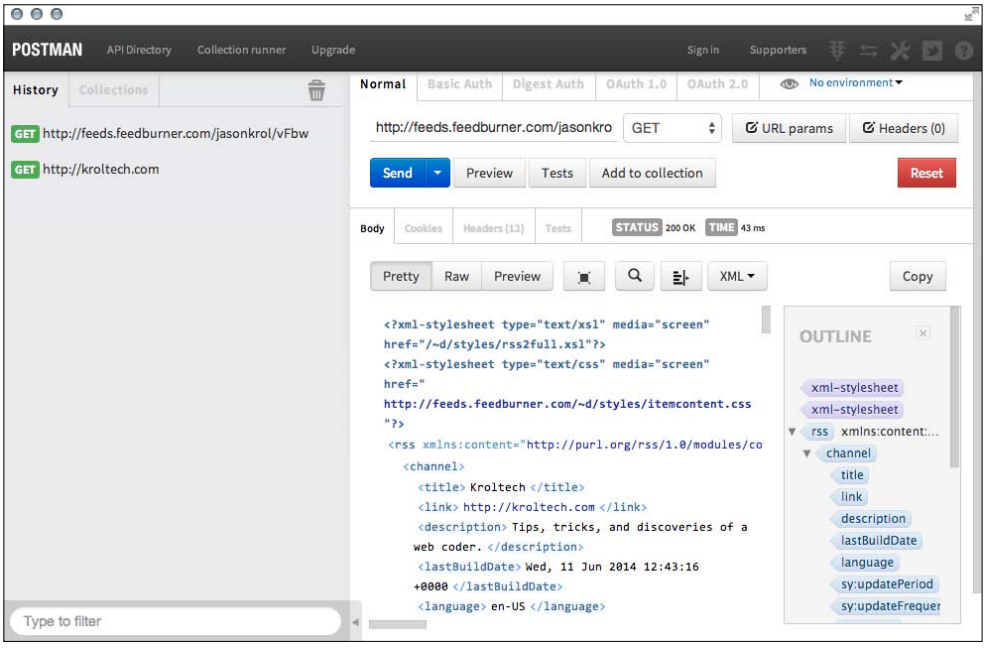


A quick tour of Postman REST Client

Using Postman REST Client, we're able to submit REST API calls to any endpoint we want as well as modify the type of request. Then, we can have complete access to the data that's returned from the API as well as any errors that might have occurred. To test an API call, enter the URL to your favorite website in the **Enter request URL here** field and leave the dropdown next to it as `GET`. This will mimic a standard `GET` request that your browser performs anytime you visit a website. Click on the blue **Send** button. The request is made and the response is displayed at the bottom half of the screen. In the following screenshot, I sent a simple GET request to `http://kroltech.com` and the HTML is returned as follows:

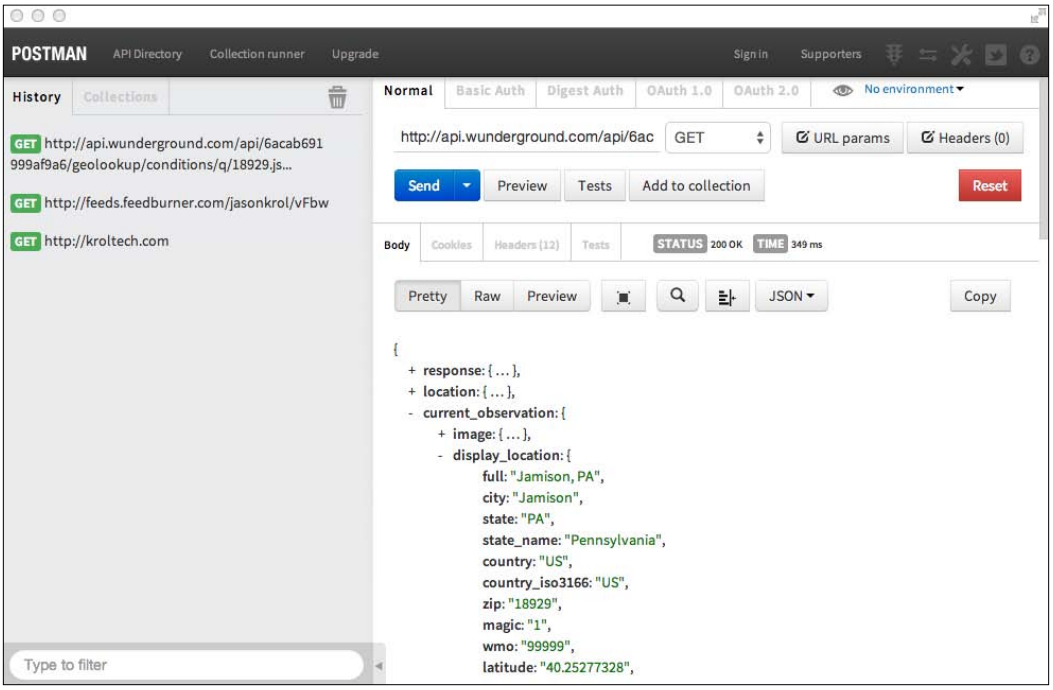


If we change this URL to that of the RSS feed URL for my website, you can see the XML returned:



The XML view has a few more features as it exposes the sidebar to the right that gives you a handy outline to glimpse the tree structure of the XML data. Not only that, you can now see a history of the requests we've made so far along the left sidebar. This is great when we're doing more advanced `POST` or `PUT` requests and don't want to repeat the data setup for each request while testing an endpoint.

Here is a sample API endpoint I submitted a `GET` request to that returns the JSON data in its response:

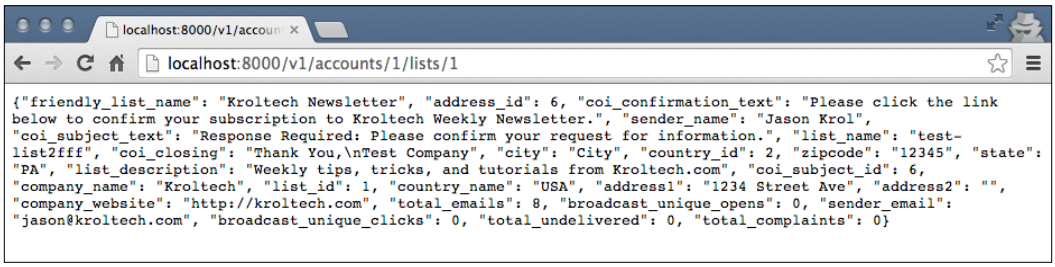


A really nice thing about making API calls to endpoints that return JSON using Postman Client is that it parses and displays the JSON in a very nicely formatted way, and each node in the data is expandable and collapsible.

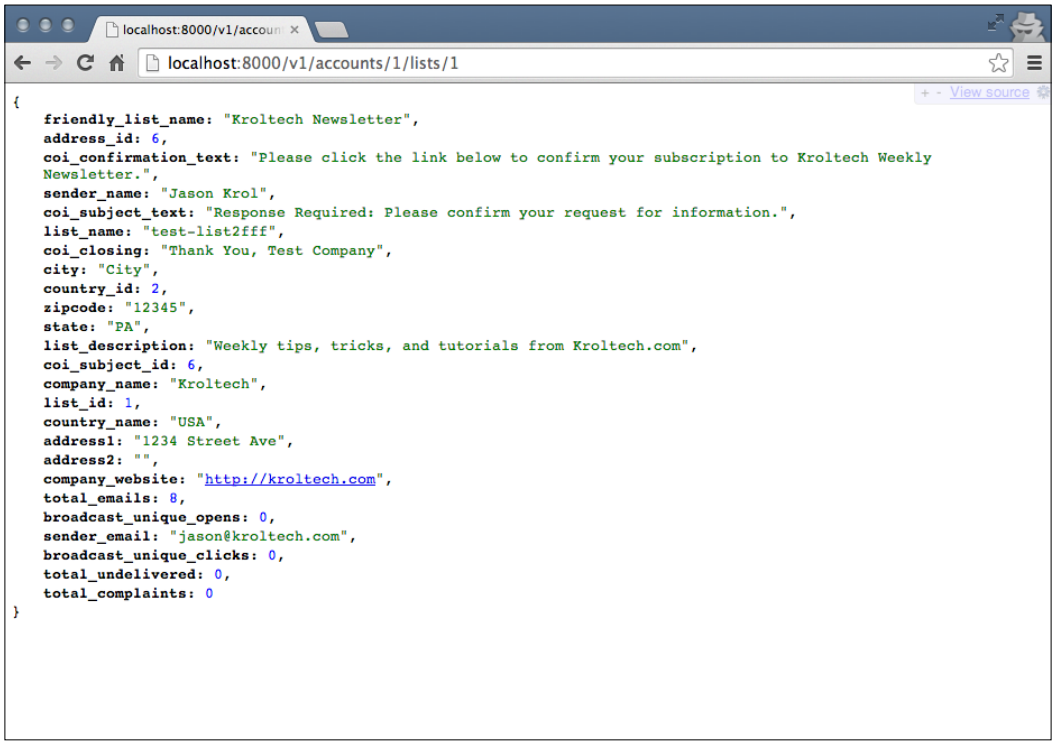
The app is very intuitive so make sure you spend some time playing around and experimenting with different types of calls to different URLs.

Using the JSONView Chrome extension

There is one other tool I want to let you know about (while extremely minor) that is actually a really big deal. The JSONView Chrome extension is a very small plugin that will instantly convert any JSON you view directly via the browser into a more usable JSON tree (exactly like Postman Client). Here is an example of pointing to a URL that returns JSON from Chrome before JSONView is installed:



And here is that same URL after JSONView has been installed:



You should install the JSONView Google Chrome extension the same way you installed Postman REST Client—access the Chrome Web Store and perform a search for `JSONView`.

Now that you have the tools to be able to easily work with and test API endpoints, let's take a look at writing your own and handling the different request types.

Creating a Basic API server

Let's create a super basic Node.js server using Express that we'll use to create our own API. Then, we can send tests to the API using Postman REST Client to see how it all works. In a new project workspace, first install the npm modules that we're going to need in order to get our server up and running:

```
$ npm init
$ npm install --save express body-parser underscore
```

Now that the `package.json` file for this project has been initialized and the modules installed, let's create a basic server file to bootstrap up an Express server. Create a file named `server.js` and insert the following block of code:

```
var express = require('express'),
    bodyParser = require('body-parser'),
    _ = require('underscore'),
    json = require('./movies.json'),
    app = express();

app.set('port', process.env.PORT || 3500);

app.use(bodyParser.urlencoded());
app.use(bodyParser.json());

var router = new express.Router();
// TO DO: Setup endpoints ...
app.use('/', router);

var server = app.listen(app.get('port'), function() {
    console.log('Server up: http://localhost:' + app.get('port'));
});
```

Most of this should look familiar to you. In the `server.js` file, we are requiring the express, body-parser, and underscore modules. We're also requiring a file named `movies.json`, which we'll create next.

After our modules are required, we set up the standard configuration for an Express server with the minimum amount of configuration needed to support an API server. Notice that we didn't set up Handlebars as a view-rendering engine because we aren't going to be rendering any HTML with this server, just pure JSON responses.

Creating sample JSON data

Let's create the sample `movies.json` file that will act as our temporary data store (even though the API we build for the purposes of demonstration won't actually persist data beyond the app's life cycle):

```
[{
    "Id": "1",
    "Title": "Aliens",
    "Director": "James Cameron",
    "Year": "1986",
    "Rating": "8.5"
},
{
    "Id": "2",
    "Title": "Big Trouble in Little China",
    "Director": "John Carpenter",
    "Year": "1986",
    "Rating": "7.3"
},
{
    "Id": "3",
    "Title": "Killer Klowns from Outer Space",
    "Director": "Stephen Chiodo",
    "Year": "1988",
    "Rating": "6.0"
},
{
    "Id": "4",
    "Title": "Heat",
    "Director": "Michael Mann",
    "Year": "1995",
    "Rating": "8.3"
```

```
},
{
    "Id": "5",
    "Title": "The Raid: Redemption",
    "Director": "Gareth Evans",
    "Year": "2011",
    "Rating": "7.6"
}]
```

This is just a really simple JSON list of a few of my favorite movies. Feel free to populate it with whatever you like. Boot up the server to make sure you aren't getting any errors (note we haven't set up any routes yet, so it won't actually do anything if you tried to load it via a browser):

```
$ node server.js
Server up: http://localhost:3500
```

Responding to GET requests

Adding a simple `GET` request support is fairly simple, and you've seen this before already in the app we built. Here is some sample code that responds to a `GET` request and returns a simple JavaScript object as JSON. Insert the following code in the routes section where we have the `// TO DO: Setup endpoints ... waiting` comment:

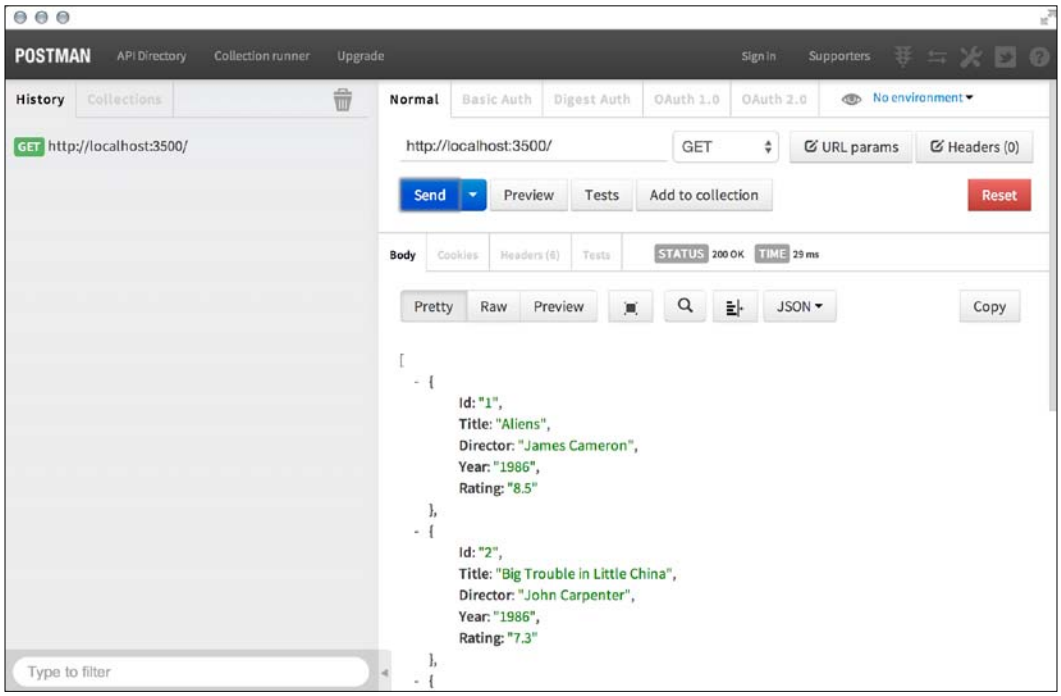
```
router.get('/test', function(req, res) {
    var data = {
        name: 'Jason Krol',
        website: 'http://kroltech.com'
    };

    res.json(data);
});
```

Just like we set up `viewModel` in *Chapter 5, Dynamic HTML with Handlebars*, we create a basic JavaScript object that we can then send directly as a JSON response using `res.json` instead of `res.render`. Let's tweak the function a little bit and change it so that it responds to a `GET` request against the root URL (that is `/`) route and returns the JSON data from our movies file. Add this new route after the `/test` route added previously:

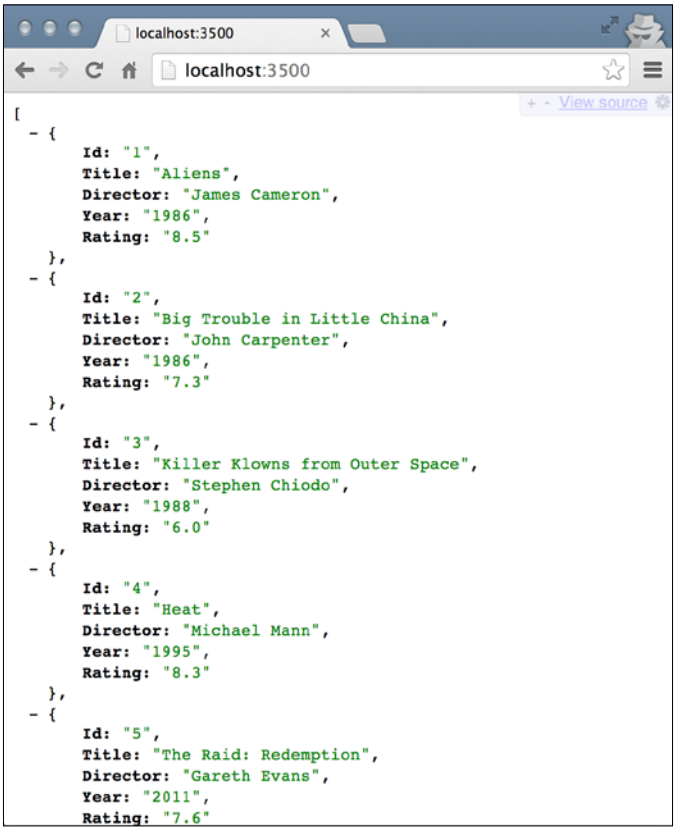
```
router.get('/', function(req, res) {
    res.json(json);
});
```

The `res` (response) object in Express has a few different methods to send data back to the browser. Each of these ultimately falls back on the base `send` method, which includes header information, statusCodes, and so on. `res.json` and `res.jsonp` will automatically format JavaScript objects into JSON and then send using `res.send`. `res.render` will render a template view as a string and then send it using `res.send` as well.

With that code in place, if we launch the `server.js` file, the server will be listening for a `GET` request to the `/` URL route and will respond with the JSON data of our movies collection. Let's first test it out using the Postman REST Client tool:



`GET` requests are nice because we could have just as easily pulled that same URL via our browser and received the same result:



However, we're going to use Postman for the remainder of our endpoint testing as it's a little more difficult to send `POST` and `PUT` requests using a browser.

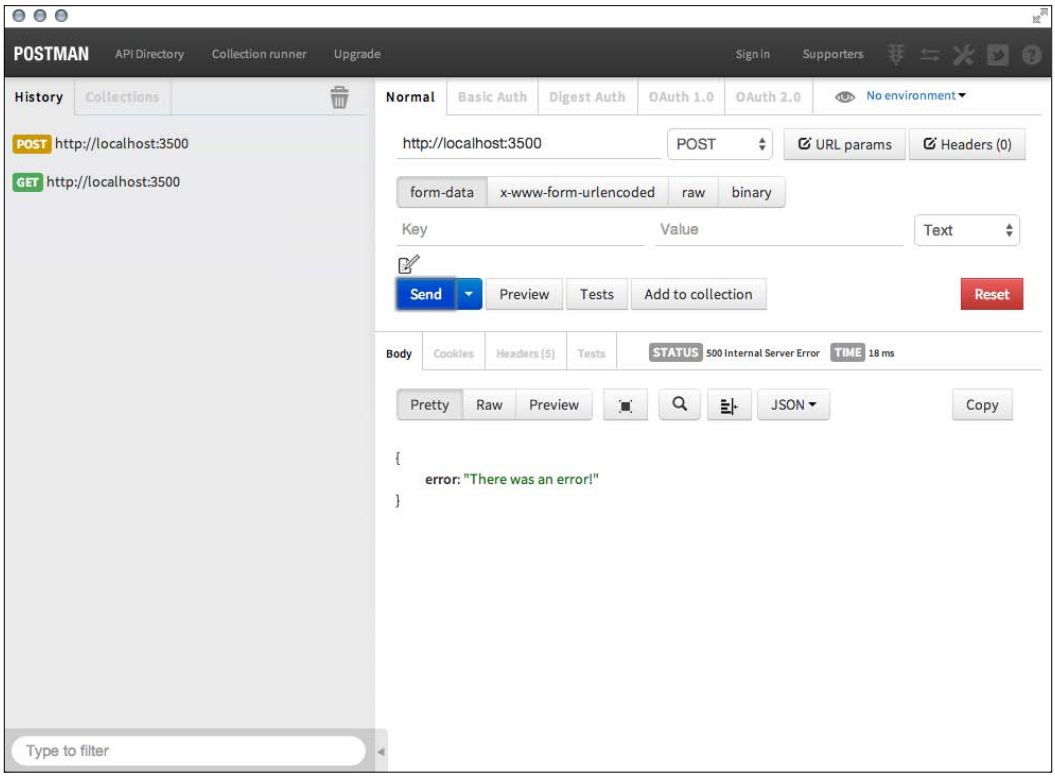
Receiving data – POST and PUT requests

When we want to allow our users using our API to insert or update data, we need to accept a request from a different HTTP verb. When inserting new data, the `POST` verb is the preferred method to accept data and know it's for an insert. Let's take a look at code that accepts a `POST` request and data along with the request, and inserts a record into our collection and returns the updated JSON. Insert the following block of code after the route you added previously for `GET`:

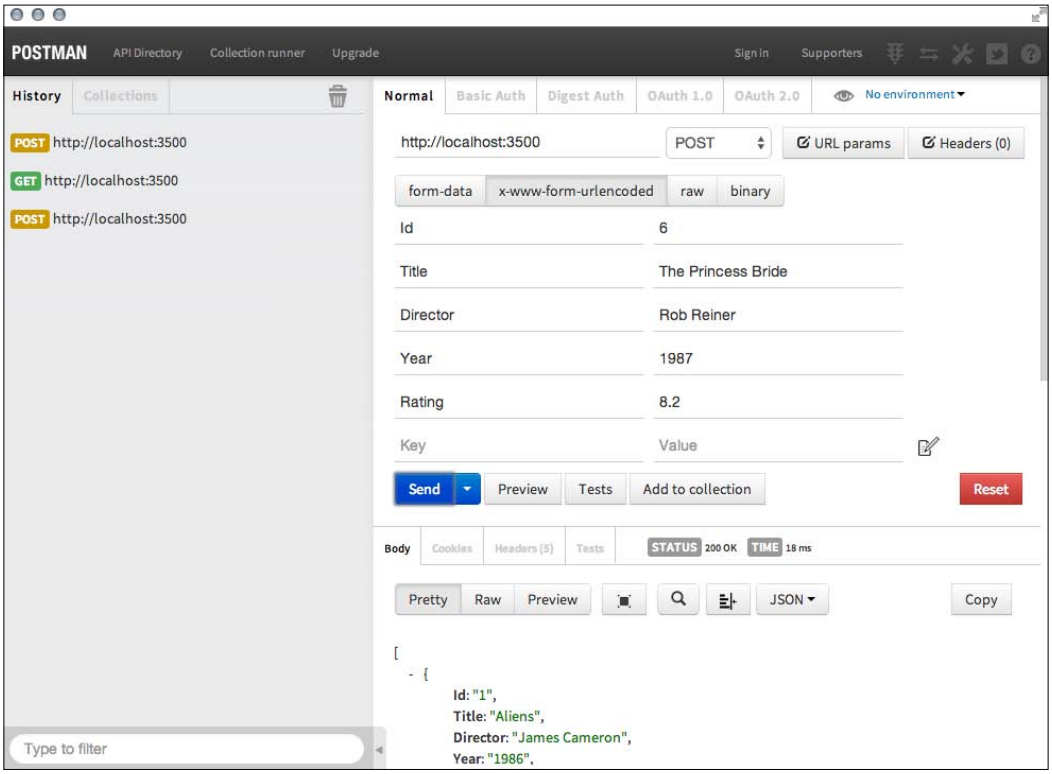
```
router.post('/', function(req, res) {
    // insert the new item into the collection (validate first)
```

```
    if(req.body.Id && req.body.Title && req.body.Director && req.body.
Year && req.body.Rating) {
        json.push(req.body);
        res.json(json);
    } else {
        res.json(500, { error: 'There was an error!' });
    }
});
```

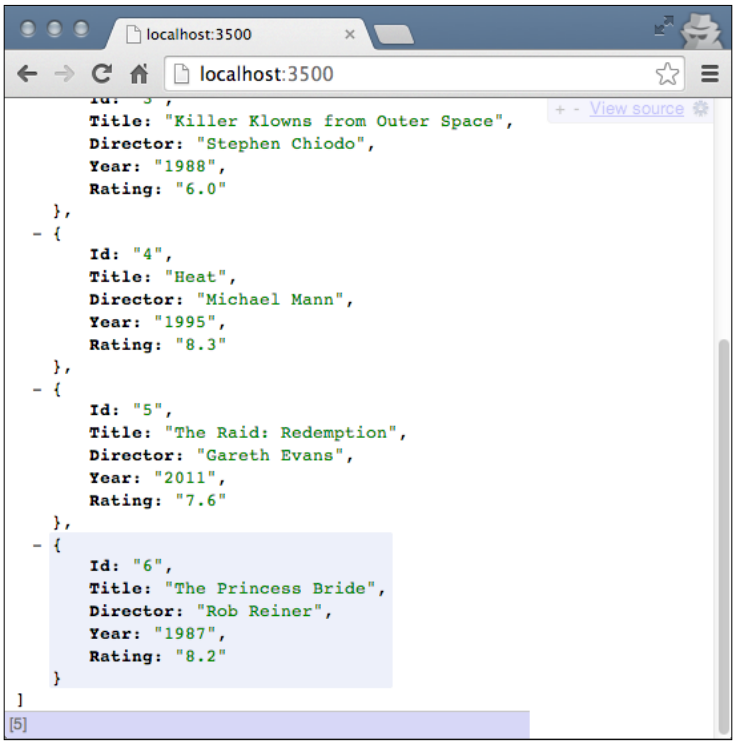
You can see the first thing we do in the `POST` function is check to make sure the required fields were submitted along with the actual request. Assuming our data checks out and all the required fields are accounted for (in our case every field), we insert the entire `req.body` object into the array *as is* using the array's `push` function. If any of the required fields aren't submitted with the request, we return a 500 error message instead. Let's submit a `POST` request this time to the same endpoint using the Postman REST Client. (Don't forget to make sure your API server is running with `node server.js`.):



First, we submitted a `POST` request with no data, so you can clearly see the 500 error response that was returned.



Next, we provided the actual data using the `x-www-form-urlencoded` option in Postman and provided each of the name/value pairs with some new custom data. You can see from the results that the **STATUS** was **200**, which is a success and the updated JSON data was returned as a result. Reloading the main `GET` endpoint in a browser yields our original movies collection with the new one added.

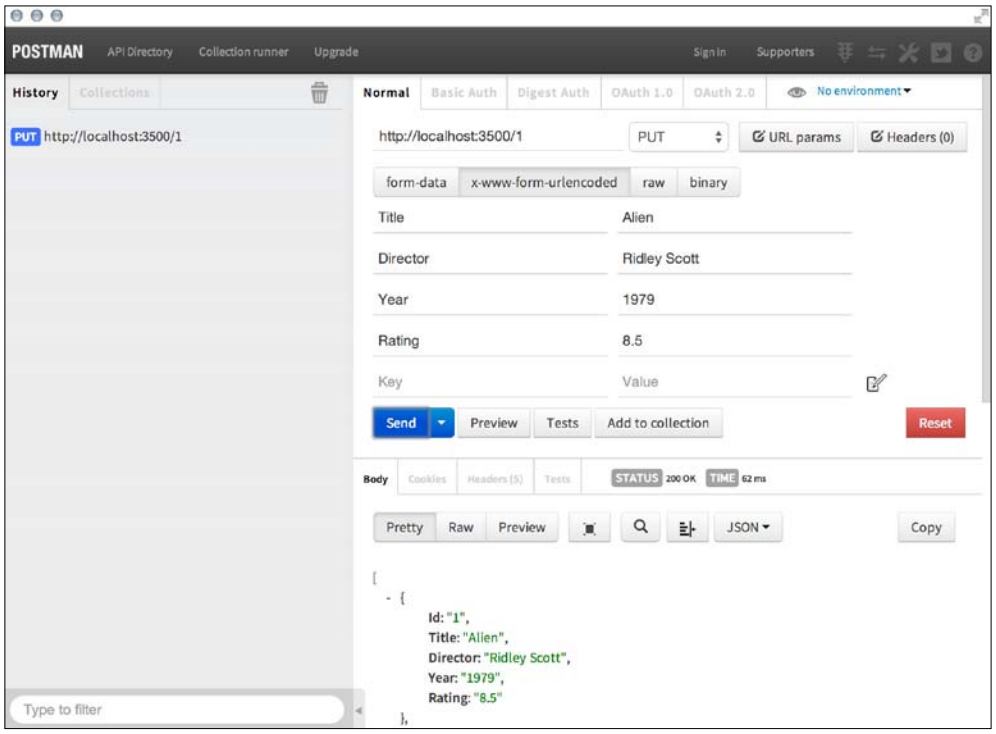


`PUT` requests will work in almost exactly the same way except traditionally, the `Id` property of the data is handled a little differently. In our example, we are going to require the `Id` attribute as a part of the URL and not accept it as a parameter in the data that's submitted (since it's usually not common for an update function to change the actual `Id` of the object it's updating). Insert the following code for the `PUT` route after the existing POST route you added earlier:

```
router.put('/:id', function(req, res) {
    // update the item in the collection
    if(req.params.id && req.body.Title && req.body.Director && req.
body.Year && req.body.Rating) {
        _.each(json, function(elem, index) {
            // find and update:
            if (elem.Id === req.params.id) {
                elem.Title = req.body.Title;
```

```
                elem.Director = req.body.Director;
                elem.Year = req.body.Year;
                elem.Rating = req.body.Rating;
            }
        });

        res.json(json);
    } else {
        res.json(500, { error: 'There was an error!' });
    }
});
```

This code again validates that the required fields are included with the data that was submitted along with the request. Then, it performs an `_.each` loop (using the underscore module) to look through the collection of movies and find the one whose `Id` parameter matches that of the `Id` included in the URL parameter. Assuming there's a match, the individual fields for that matched object are updated with the new values that were sent with the request. Once the loop is complete, the updated JSON data is sent back as the response. Similarly, in the `POST` request, if any of the required fields are missing, a simple 500 error message is returned. The following screenshot demonstrates a successful `PUT` request updating an existing record.



The response from Postman after including the value `1` in the URL as the `Id` parameter, which provides the individual fields to update as `x-www-form-urlencoded` values, and finally sending as `PUT` shows that the original item in our movies collection is now the original Alien (not Aliens, its sequel as we originally had).

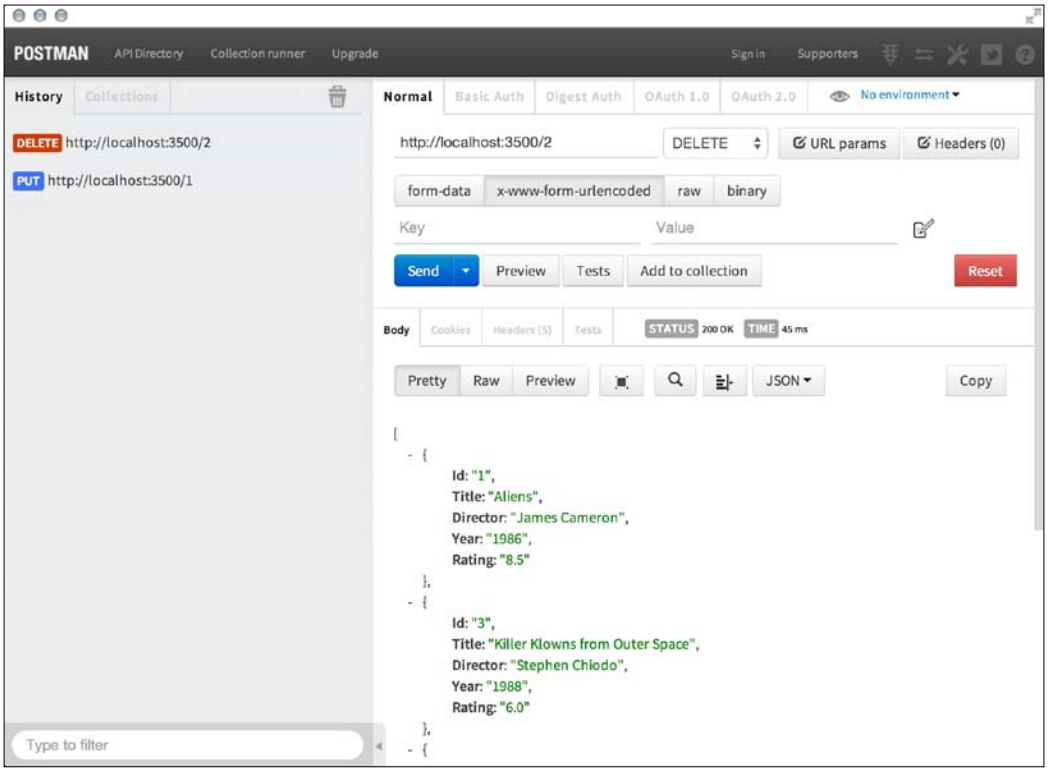
Removing data – DELETE

The final stop on our whirlwind tour of the different REST API HTTP verbs is `DELETE`. It should be no surprise that sending a `DELETE` request should do exactly what it sounds like. Let's add another route that accepts `DELETE` requests and will delete an item from our movies collection. Here is the code that takes care of `DELETE` requests that should be placed after the existing block of code from the previous `PUT`:

```
router.delete('/:id', function(req, res) {
    var indexToDel = -1;
    _.each(json, function(elem, index) {
        if (elem.Id === req.params.id) {
            indexToDel = index;
        }
    });
    if (~indexToDel) {
        json.splice(indexToDel, 1);
    }
    res.json(json);
});
```

This code will loop through the collection of movies and find a matching item by comparing the values of `Id`. If a match is found, the array index for the matched item is held until the loop is finished. Using the `array.splice` function, we can remove an array item at a specific index. Once the data has been updated by removing the requested item, the JSON data is returned. Notice in the following screenshot that the updated JSON that's returned is in fact no longer displaying the original second item we deleted.

Note that ~ in there! That's a little bit of JavaScript black magic! The tilde (~) in JavaScript will bit flip a value. In other words, take a value and return the negative of that value incremented by one, that is `~n === -(n+1)`. Typically, the tilde is used with functions that return `-1` as a false response. By using ~ on `-1`, you are converting it to a `0`. If you were to perform a Boolean check on `-1` in JavaScript, it would return `true`. You will see ~ is used primarily with the `indexOf` function and jQuery's `$.inArray()`—both return `-1` as a false response.



All of the endpoints defined in this chapter are extremely rudimentary, and most of these should never ever see the light of day in a production environment! Whenever you have an API that accepts anything other than `GET` requests, you need to be sure to enforce extremely strict validation and authentication rules. After all, you are basically giving your users direct access to your data.

Consuming external APIs from Node.js

There will undoubtedly be a time when you want to consume an API directly from within your Node.js code. Perhaps, your own API endpoint needs to first fetch data from some other unrelated third-party API before sending a response. Whatever the reason, the act of sending a request to an external API endpoint and receiving a response can be done fairly easily using a popular and well-known npm module called Request. Request was written by Mikeal Rogers and is currently the third most popular (and most relied upon) npm module after async and underscore.

Request is basically a super simple HTTP client, so everything you've been doing with Postman REST Client so far is basically what Request can do, only the resulting data is available to you in your node code as well as the response status codes and/or errors, if any.

Consuming an API endpoint using Request

Let's do a neat trick and actually consume our own endpoint as if it was some third-party external API. First, we need to ensure we have Request installed and can include it in our app:

```
$ npm install --save request
```

Next, edit `server.js` and make sure you include Request as a required module at the start of the file:

```
var express = require('express'),
    bodyParser = require('body-parser'),
    _ = require('underscore'),
    json = require('./movies.json'),
    app = express(),
    request = require('request');
```

Now let's add a new endpoint after our existing routes, which will be an endpoint accessible in our server via a `GET` request to `/external-api`. This endpoint, however, will actually consume another endpoint on another server, but for the purposes of this example, that other server is actually the same server we're currently running!

The Request module accepts an `options` object with a number of different parameters and settings, but for this particular example, we only care about a few. We're going to pass an object that has a setting for the method (GET, POST, PUT, and so on) and the URL of the endpoint we want to consume. After the request is made and a response is received, we want an inline callback function to execute.

Place the following block of code after your existing list of routes in `server.js`:

```
router.get('/external-api', function(req, res) {
    request({
            method: 'GET',
            uri: 'http://localhost:' + (process.env.PORT || 3500),
        }, function(error, response, body) {
            if (error) { throw error; }

            var movies = [];
            _.each(JSON.parse(body), function(elem, index) {
                movies.push({
                    Title: elem.Title,
                    Rating: elem.Rating
                });
            });
            res.json(_.sortBy(movies, 'Rating').reverse());
        });
});
```

The callback function accepts three parameters: `error`, `response`, and `body`. The `response` object is like any other response that Express handles and has all of the various parameters as such. The third parameter, `body`, is what we're really interested in. That will contain the actual result of the request to the endpoint that we called. In this case, it is the JSON data from our main `GET` route we defined earlier that returns our own list of movies. It's important to note that the data returned from the request is returned as a string. We need to use `JSON.parse` to convert that string to actual usable JSON data.

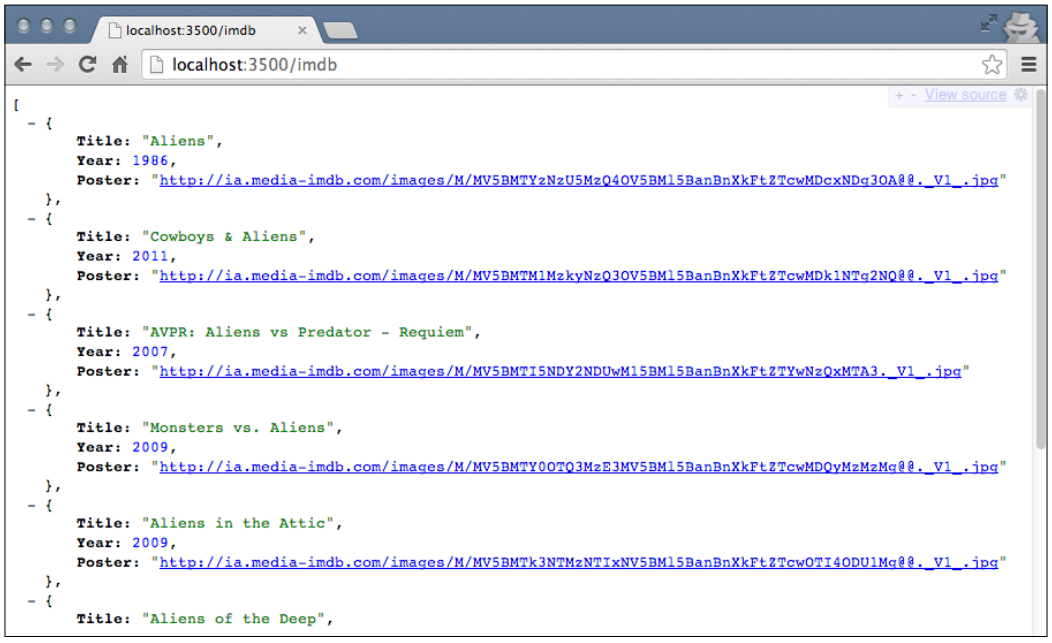
Using the data that came back from the request, we transform it a little bit. That is, we take that data and manipulate it a bit to suit our needs. In this example, we took the master list of movies and just returned a new collection that consists of only the `title` and `rating` of each movie and then sorts the results by the top scores. Load this new endpoint by pointing your browser to `http://localhost:3500/external-api`, and you can see the new transformed JSON output to the screen.

Let's take a look at another example that's a little more real world. Let's say that we want to display a list of similar movies for each one in our collection, but we want to look up that data somewhere such as `www.imdb.com`. Here is the sample code that will send a `GET` request to IMDB's JSON API, specifically for the word `aliens`, and returns a list of related movies by the title and year. Go ahead and place this block of code after the previous route for `external-api`:

```
router.get('/imdb', function(req, res) {
    request({
            method: 'GET',
```

```
            uri: 'http://sg.media-imdb.com/suggests/a/aliens.json',
        }, function(err, response, body) {
            var data = body.substring(body.indexOf('(')+1);
            data = JSON.parse(data.substring(0,data.length-1));
            var related = [];
            _.each(data.d, function(movie, index) {
                related.push({
                    Title: movie.l,
                    Year: movie.y,
                    Poster: movie.i ? movie.i[0] : ''
                });
            });

            res.json(related);
        });
});
```

If we take a look at this new endpoint in a browser, we can see the JSON data that's returned from our `/imdb` endpoint is actually itself retrieving and returning data from some other API endpoint:



Note that the JSON endpoint I'm using for IMDB isn't actually from their API, but rather what they use on their homepage when you type in the main search box. This would not really be the most appropriate way to use their data, but it's more of a hack to show this example. In reality, to use their API (like most other APIs), you would need to register and get an API key that you would use so that they can properly track how much data you are requesting on a daily or an hourly basis. Most APIs will to require you to use a private key with them for this same reason.

Summary

In this chapter, we took a brief look at how APIs work in general, the RESTful API approach to semantic URL paths and arguments, and created a bare bones API. We used Postman REST Client to interact with the API by consuming endpoints and testing the different types of request methods (`GET`, `POST`, `PUT`, and so on). You also learned how to consume an external API endpoint by using the third-party node module Request.

In the next chapter, we will revisit our original application as we implement best practices by introducing testing in Node.js. We'll take a look at popular testing frameworks and write tests for the application to prove that our code works as expected.

9
Testing Your Code

Up until this point, we've been pretty much flying by the seat of our pants when it comes to the code we've been writing! We've literally had no way of knowing if the code worked until we tested it out in an actual browser.

In this chapter, we will cover the following topics:

- Running tests with the Mocha test framework
- Writing tests with the Chai assertion library
- Spies and Stubs with Sinon and Proxyquire
- Writing your first test
- Testing our application

Tests are great for making sure your code functions properly, but they're also awesome for preventing new unexpected bugs from suddenly popping up because of an innocent little change you made to some unsuspecting code.

Tools of the trade

Let's start by taking a look at the various tools and libraries we're going to be using to run and write our tests. There are three main concepts we need to cover before we can actually start writing real tests. The first is a test runner, or the framework we use to run our suite of tests. The second is the assertion library itself, the language we use to write our tests. Finally, we'll take a look at the idea of spies and stubs, which are fake representatives of certain parts of our code that are relied on when we need to track function calls to ensure an expected behavior.

Running tests with the Mocha framework

When writing tests for an application, you typically write them in batches that are module specific. These batches are referred to as suites or specs. Each suite typically contains a batch of tests organized in a way that almost mirrors the application itself. With Node, the idea is no different in that each suite of tests we write will be specific to an individual module. You'll require the module you want to test against, and write a collection of tests for each part of the module's functionality.

Since you'll have many different test files testing each and every component of your application, you'll want a way to quickly execute all of the tests. This is where the test runner comes in. The test runner that we've decided to use is called Mocha. You can install Mocha globally like any other npm package:

```
$ npm install -g mocha
```

Once installed, the Mocha command-line tool is now available. Simply executing `mocha` from a command line will execute the test run with a few default options. Most notably, the test runner will look for a folder named `'test'` and any `.js` file within. In our case, we haven't actually set up any tests yet so executing `mocha` alone won't actually accomplish anything.

When the Mocha test runner does find any `.js` files, it executes them like any other Node file except it looks for a few specific keywords within the file.

The first thing Mocha will scan the file for is a `describe` block. A `describe` block is a way to define a specific group of tests. You can have many `describe` blocks in a test file, and each `describe` block can have many specific tests. In addition, `describe` blocks can be nested as deep as you like to better organize your tests.

Once a `describe` block is found, a few other items are executed within it.

A `beforeEach` and `afterEach` block is checked for to see if there is any pretest work that needs to be executed before each test is executed. Likewise, any cleanup that needs to occur between tests can be taken care of within the `afterEach` block. Both of these blocks are optional and therefore not required. A good example of when you would want to use a `beforeEach` block is if you need to instantiate an object that you will be testing, you would want to create a new instance before every single test. This way, whatever changes a test might push to the object will be reset and will not inadvertently affect any other tests. Likewise, any changes you've made during a test to any other related objects can be reset during an `afterEach` block.

Within the `describe` block, defining individual tests is done with `it` statements. Within each `it` statement, it's generally considered good practice to include a single `expect` to assert the actual test (although you can include as many `expect` function calls as you like, its still only considered a single test because of the single `it`.) Here is some sample code for a typical test block:

```
describe('The code', function() {
    beforeEach(function(){
        // optional preparation for each test
    });
    afterEach(function(){
        // optional cleanup after each test
    });

    it('should test something', function(){
        var something = 1;
        // here we "expect" some condition to declare our test
        // in this case, we expect the variable to exist
        // more on the assertion syntax a little later
        expect(something).to.exist;
    });
    it('should test something_else', function(){
        var something_else = false;
        // now we test a different variable against its value
        // and expect that value to equal false
        expect(something_else).to.equal(false);
    });
});
```

We're using the **Behavior-driven Development** (**BDD**) style syntax when writing our suites, which allows our tests to read like user stories. With the preceding example, you can read the tests as "The code should test something" and "The code should test something else". In fact, if we ran the previous tests we would see the following output:

```
The code
   should test something
   should test something_else


2 passing (5ms)
```

Asserting tests with Chai.js

As you saw in the previous example, we used special blocks to define our test groups with Mocha but we used a separate language when defining our actual individual tests. These tests are called assertions and we chose to use the Chai.js library. This is purely a personal preference, as there are a number of different assertion libraries that exist. Each library does basically the same thing with slight variations on the syntax and style of actually writing the tests.

Chai itself has a few different flavors of API styles that can be used when writing tests. The BDD API, which is what we will use for the tests we write, uses `expect` and `should`. There's also the assert API, which is more of a **Test-driven Development** (**TDD**) style. The benefit of using the BDD style with `expect`/`should` is that you can chain the assertion methods to improve readability of the tests.

You can learn more about BDD as well as TDD by accessing the following Wikipedia page:
`http://en.wikipedia.org/wiki/Behavior-driven_development`

Using the BDD assertion API with Chai provides a number of methods at our disposal:

- `to`
- `be`
- `been`
- `is`
- `that`
- `and`
- `has`
- `have`
- `with`
- `at`
- `of`
- `same`

All of these will follow an `expect()` statement and can be coupled with `not` to flip the assertion. In addition, they will be combined with any of the following Chai methods to determine a test's outcome:

- `ok`
- `true`
- `false`
- `null`
- `undefined`
- `exist`
- `empty`
- `equal`
- `eql`
- `above`
- `least`
- `below`
- `most`
- `within`
- `instanceof`
- `property`
- `match`
- `string`
- `respondTo`

Here are a few examples:

```
var foo = 'bar';
expect(foo).to.equal('bar')
foo = false;
expect(foo).to.not.equal(true);
expect(true).to.be.ok;
expect(true).to.be.true;
expect(false).to.be.false;
expect(somevar).to.be.undefined;
expect(foo).to.not.be.undefined;
expec(5).to.be.within(0,10);
```

There are many different assertion methods that can be used and combined in different ways. For a more detailed list, refer to the Chai documentation by visiting: `http://chaijs.com/api`.

Installing Chai.js as a devDependency

Since Chai is project specific and based on a personal preference, we're going to install it as a project dependency (instead of globally). In addition, as our tests are not actually required for our application to run, we'll include the dependency as `devDependency`. What this means is that performing `npm install` on a developers machine will install all of the dependencies listed in the `dependencies` list so that an application can run but it will also install all of the development-specific dependencies listed in `devDependencies` as well. When `npm install` is performed on a production server the application is loaded on, only the `dependencies` list will be installed (since developers typically aren't developing directly on a production server).

In order to include Chai in our project as a `devDependency`, we will use the `--save-dev` flag instead of `--save` when performing `npm install`:

```
$ npm install --save-dev chai
```

Spies and stubs with Sinon.js

Testing your code will prove to be extremely difficult if there isn't an easy way to "spy" on functions and know whenever they are called. Additionally, when one of your functions is called, it will be nice to know what arguments were passed to it and what was returned. A spy in testing is a special placeholder function that replaces an existing function when you want to check specifically if/when it was called. Spies track a number of properties for a function when it's called and can also pass through to the expected functionality of the original function.

Imagine you have a function that simply adds two numbers together and returns the sum:

```
var sum = function(a, b) {
    return a + b;
}
var doWork = function() {
    var x = 1,
        y = 2;
    console.log(sum(x,y));
}
```

When writing a test for the `doWork` function, we want to assert that the `sum` function was called. We don't necessarily care what the function does or that it even works; we just want to make sure since `doWork` relies on `sum` that it's actually calling the function. In this scenario, the only way we could be sure is if we had a way to "spy" on the `sum` function and know if it was ever called. Using a `spy`, we can do just that:

```
describe('doWork', function() {
    var sum;

    it('should call sum', function() {
        sum = sinon.spy();
        doWork();
        expect(sum).to.be.calledWith(1,2);
    });
});
```

In the preceding scenario, the `sum` function is replaced with a `spy` function. So its actual functionalities will no longer exist. If we want to ensure that the `sum` function is not only spied on but still functions the way we expect, we need to attach `.andCallThrough()` after `sinon.spy()`:

```
describe('doWork', function() {
    var sum;
    console.log = sinon.spy();

    it('should call sum', function() {
        sum = sinon.spy().andCallThrough();
        doWork();
        expect(sum).to.be.calledWith(1,2);
        expect(console.log).to.be.calledWith(3);
    });
});
```

Notice that by including `andCallThrough` on our `sum` spy, we're able to not only spy on it and assert that it was called but also spy on the `console.log` function and assert that it was called with the correct value returned by `sum`.

Where a spy is typically just a watcher to a function and only reports if the function was called, a stub allows you to provide custom functionalities for a function on-the-fly during test execution.

Think of a stub as a super spy, where it reports the same things that a spy does, but also performs whatever specific tasks you want as well. Using the same example, let's stub the `sum` function to always return the same value:

```
it('should console.log sum response', function(){
    // replace the existing sum function with a new stub,
    // a generic function that does exactly what we specify
    // in this case always just return the number 2
    sum = sinon.stub(function(){
        return 2;
    });
    // lets replace the standard console.log function
    // with a spy
    console.log = sinon.spy();
    // call our doWork function (which itself uses console.log)
    doWork();
    // and if doWork executed the way its supposed to, console.log
    // should have been called and the parameter 2 passed to it
    expect(console.log).to.be.calledWith(2);
});
```

Stubbing a function is great when a function performs work that might yield unexpected results, and you just want to force the response for the purposes of your test. Stubbing is also handy when you're doing TDD and you're testing against a function that you haven't even written yet.

The Sinon.js library provides both spy and stub functionalities and is quite extensive. For a complete list of the different options available with this powerful framework, I strongly recommend you spend some time reading the documentation at `http://sinonjs.org/docs`.

Since we are going to be using Sinon.js with our tests, we should install it as another `devDependency` exactly the same way we did with Chai.js. In addition, we should also install the `sinon-chai` helper, which provides additional Chai assertion verbs specifically for use with Sinon:

```
$ npm install --save-dev sinon sinon-chai
```

The inclusion of `sinon-chai` allows us to write assertions such as `to.be.calledWith`, which would otherwise not work with Chai alone.

Stubbing node modules with Proxyquire

Spies and stubs are great when writing tests against code within the same module, but when you need to spy on or stub a module required within another node module, things get a little trickier. Fortunately, there's a tool called Proxyquire that will allow you to stub modules that are required from your code.

Examine the following code sample:

```
// google.js
var request = require('request');

module.exports = function() {
    request('http://www.google.com', function (err, res, body) {
        log(body);
    });
}
```

You can see that we require the `request` module. The `request` module accepts two parameters, the second of which is a callback function. This is where things start to get tricky. How are we going to implement spies and/or stubs in this type of scenario? Furthermore, how can we prevent our tests from explicitly making a network call to fetch `google.com`? What if `google.com` is down (ha!) when we run our tests?

In order to be able to spy on the request module, we need a way to intercept the actual `require` and attach our own stubbed version of `request` instead. The `request` module is actually a great example of a module that you would want to stub because request is used to make a network call, and that's something that you want to make sure your tests never actually do. You don't want your tests relying on an external resource like a network connection or being dependent on the data returned from a live request.

Using Proxyquire, we can actually set up our tests in a way that they'll intercept the `require` module and replace what gets executed with our own stub. Here's an example of a test file written against the module we created earlier:

```
var log = sinon.spy(),
    requestStub = sinon.stub().callsArgWith(1, null, null, 'google.
com'),
    google = proxyquire('../google', { 'request': requestStub });
```

```
describe('google module', function(){
    beforeEach(function() {
        google();
    });
    it('should request google.com', function() {
        expect(reqstub).to.be.called();
    });
    it('should log google body', function(){
        expect(callback).to.be.calledWith(null, null, 'google.com');
    });
});
```

The first thing the test suite does is set up a spy and generic stub function that will be used as the request module. Then, we include our `google` module but we include it using `proxyquire` instead of a typical `require` module. Using `proxyquire`, we pass the path to the module the same way we would with `require`, except the second parameter is the module that would be required within that module and the stub function to use in its place.

Before each test, we execute the original `google` module and assert against our stub that it was in fact called. Additionally, we assert that the log spy was called with whatever data was returned from the `request` module. Since we are in control of that module, we can test, quite literally, that the string `google.com` was returned when a request was made to `http://google.com` (which we know for a fact is not true—not only that, but we know that a network call was never sent to `www.google.com` either).

We're using a special power of a stub that allows us to execute a particular parameter to the stubbed function assuming it was a callback function. Here, we're using `callsArgWith` and including the argument index (zero based) as the first parameter; in this case, `1`. Of the two parameters that were passed to request, the first (index 0) was the URL itself and the second (index 1) was the callback function. By using `callsArgWith`, we can execute the callback function and specifically provide its parameters; in this case, null, null, and a string.

Like Sinon.js and Chai.js, Proxyquire will also need to be included in our project as `devDependency`:

```
$ npm install --save-dev proxyquire
```

Writing and running your first test

Up to this point, all of the test code we've seen has just been demos and examples and we haven't actually run any tests. Let's set up the basic structure of our application so that we can start writing real tests.

The first thing to do is set up the folder structure that will house all of our tests. Within the root of the application project folder, create a folder named `tests`. Within the `tests` folder, create three more folders for `controllers`, `models`, and `server`:

```
/(existing app root)
tests/
----/controllers/
----/models/
----/server/
```

Writing a test helper

Before we start writing the tests for our application, there's a small amount of overhead we need to take care of to prepare for our tests. To take care of this overhead, we're going to write a test helper file that will be included and run with every test file we execute via Mocha.

Create a file named `testhelper.js` within the `tests` folder and insert the following block of code:

```
var chai = require('chai'),
    sinon = require('sinon'),
    sinonChai = require('sinon-chai');

global.expect = chai.expect;
global.sinon = sinon;
chai.use(sinonChai);
```

This is code that we would typically need to include at the top of every one of our test files, but by including it in a single file we can instruct Mocha to automatically require this file for every test file that is run. The file itself just includes the `chai` and `sinon` modules and defines a few `globals` variables as shortcuts for our test writing. Additionally, it instructs `chai` to use the `sinonChai` module so that our syntax is extended and we can write Sinon-specific Chai assertions.

The command to actually run our suite of tests is:

```
$ mocha -r tests/testhelper.js -R spec tests/**/*.test.js
```

Remember that we installed Mocha globally earlier so that we can execute the `mocha` command from anywhere.

Based on the path to our tests in the preceding command, it's assumed that the command will be executed from the root of the application project folder. The `-r` flag instructs Mocha to require the `testhelper.js` module. The `-R` flag is an option to define the style of the test reporting output. We chose to use the `spec` style, which lists our report in a nested indentation style with each `describe` and `it` statement along with a green checkmark for the passed tests. Finally, the last argument is the path to our test files; in this case, we provided wildcards so that all of our tests will be run.

Mocha has a few different reporting styles that you can choose from. These include dot (repeating dots for each test), list, progress (a percentage bar), json, and spec. One of the more interesting, albeit somewhat useless, is the `-R nyan` reporting style.

Executing that Mocha command from earlier at this point will simply return `0 passing (2ms)` because we don't have any tests yet. Let's write a quick sample test to make sure our project is properly set up. Within the `tests` folder, create a new file named `mocha.test.js` and include the following code:

```
describe('Mocha', function() {
    describe('First Test', function() {
        it('should assert 1 equals 1', function() {
            expect(1).to.equal(1);
        });
    });
});
```

The preceding test is pretty straightforward and simply asserts that `1` is equal to `1`. Save this file and run the Mocha test command again, and you should get the following output:

```
$ mocha -r tests/testhelper.js -R spec tests/mocha.test.js
Mocha
  First Test
    should assert 1 equals 1


1 passing (5ms)
```

You may find remembering and executing that long convoluted command for Mocha to be tiresome and frustrating. Fortunately, there's a pretty easy solution. Edit the `package.json` file in the application and add the following section:

```
  "scripts": {
      "start": "node server.js",
      "test": "mocha -r tests/testhelper.js -R spec tests/**/*.test.js"
    },
```

By providing this tweak to the `package.json` file, you can now simply execute `npm test` from a command line as a quick and easy shortcut. This is a standard convention with the `package.json` file so other developers will know to simply execute `npm test` whenever they want to run tests for your project.

Now that the `package.json` file has been updated, you can simply execute `npm test` to execute the suite of tests for the project:

```
$ npm test
> chapter9@0.0.0 test /Users/jasonk/repos/nodebook/chapter9
> mocha -r tests/testhelper.js -R spec tests/**/*.test.js


Mocha
  First Test
    should assert 1 equals 1


1 passing (5ms)
```

Now that your project is set up to properly run and execute tests, let's start writing some real tests for the application.

Testing the application

With all of that background information out of the way, let's focus on writing some real tests for the application we've built. In the following sections, we will write tests for the routes, servers, models, and controllers in our application.

Testing the routes

Let's start things a little slow by taking a look at one of the most basic files in our application, the `routes.js` file. This file simply defines the number of routes that the application should respond to. This is going to be one of the easiest files to write tests for.

Since the `routes.js` file is in the `server` folder within our main application, let's put its corresponding test file in a similar location. Within the `tests/server` folder, create a file named `routes.test.js`. Since the `routes.test.js` file is going to be testing the functionalities of our `routes.js` file, we need it to require the same modules. Include the following code in `test/server/routes.test.js`:

```
var home = require('../../controllers/home'),
    image = require('../../controllers/image'),
    routes = require('../../server/routes');
```

Notice that the paths are different since we require modules from within our `test/server` folder, but we also require app-specific modules. Also, note that in addition to the modules that our original `routes.js` file requires, we also require the `routes` module itself. How else are we going to be able to test the functionalities of the module if it isn't included? Next, let's set up the structure of the test suite and create a few spies. Include this new block of code following the previous code within `tests/server/routes.test.js`:

```
describe('Routes', function(){
    var app = {
        get: sinon.spy(),
        post: sinon.spy(),
        delete: sinon.spy()
    };
    beforeEach(function(){
        routes.initialize(app);
    });

    // to do: write tests...
});
```

If you recall, the routes module's `initialize` function accepted a single parameter, an `app` object. In our tests, we defined `app` as a simple anonymous object with three functions for `get`, `post`, and `delete`, each of which is a spy. We include a `beforeEach` block to execute the `initialize` function before every one of our tests run.

Now let's include some tests. First, we'll test that the `GET` endpoints are configured correctly. Immediately after the `// to do: write tests...` comment, place the following block of code:

```
describe('GETs', function() {
    it('should handle /', function(){
        expect(app.get).to.be.calledWith('/', home.index);
    });
    it('should handle /images/:image_id', function(){
        expect(app.get).to.be.calledWith('/images/:image_id', image.
index);
    });
});
```

Then, test the `POST` endpoints:

```
describe('POSTs', function() {
    it('should handle /images', function(){
        expect(app.post).to.be.calledWith('/images', image.create);
    });
    it('should handle /images/:image_id/like', function(){
        expect(app.post)
            .to.be.calledWith('/images/:image_id/like', image.like);
    });
    it('should handle /images/:image_id/comment', function(){
        expect(app.post)
            .to.be.calledWith('/images/:image_id/comment', image.
comment);
    });
});
```

Finally, test the `DELETE` endpoint:

```
describe('DELETEs', function() {
    it('should handle /images/:image_id', function(){
        expect(app.delete)
            .to.be.calledWith('/images/:image_id', image.remove);
    });
});
```

Each of these tests assert the same thing, that the `app` object's corresponding `get`, `post`, or `delete` function was executed with the correct parameters for each route. We were able to test against the parameters because the `app` object we used was a spy.

If you run the `mocha` command to execute the suite of tests, you should see the following output:

```
$ npm test
Routes
    GETs
       should handle /
       should handle /images/:image_id
    POSTs
       should handle /images
       should handle /images/:image_id/like
       should handle /images/:image_id/comment
    DELETEs
       should handle /images/:image_id


  6 passing (14ms)
```

Testing the server

Testing the `server.js` file will be slightly different than any of our other files. The file runs as the root of our application, so it doesn't export a module or any object that we can directly test. Since we launch our server using `server.js`, we need to emulate launching our server from our code. We'll create a function called `server`, which will require the `server.js` file using Proxyquire, and stub each of the modules that it requires itself. Executing the function `server()` will be exactly the same as executing `node server.js` from a command line. All of the code within the file will execute via that function, and then we can test against each of the calls that are made using stubs from within Proxyquire.

Create a file named `server.test.js` within the `tests/server/` folder and insert the following block of code:

```
var proxyquire, expressStub, configStub, mongooseStub, app,
    server = function() {
        proxyquire('../../server', {
            'express': expressStub,
            './server/configure': configStub,
            'mongoose': mongooseStub
        });
    };
```

```
describe('Server', function() {
    beforeEach(function(){
        proxyquire = require('proxyquire'),
        app = {
            set: sinon.spy(),
            get: sinon.stub().returns(3300),
            listen: sinon.spy()
        },
        expressStub = sinon.stub().returns(app),
        configStub = sinon.stub().returns(app),
        mongooseStub = {
            connect: sinon.spy(),
            connection: {
                on: sinon.spy()
            }
        };

        delete process.env.PORT;
    });

    // to do: write tests...
});
```

Before each test is run for our server, we reset the stubs for all of the major components of the server. These stubs include the `app` object itself, `express`, `config`, and `mongoose`. We're stubbing each of these modules since we want to spy on them (and we use a stub because some of them need to return objects that we'll work with in our file). Now that we have all of our spies in place and our `app` object scaffold set up, we can start testing the main functionalities of our code.

We need to check if the following conditions pass:

- An application is created
- The views directory is set
- The port is set and can be configured and/or defaults
- The app itself is configured (config is called with it)
- Mongoose connects to a database URI string
- Finally, the app itself is launched

Replace the `// to do: write tests...` comment in the earlier code with the following block of code:

```
describe('Bootstrapping', function(){
    it('should create the app', function(){
        server();
        expect(expressStub).to.be.called;
    });
    it('should set the views', function(){
        server();
        expect(app.set.secondCall.args[0]).to.equal('views');
    });
    it('should configure the app', function(){
        server();
        expect(configStub).to.be.calledWith(app);
    });
    it('should connect with mongoose', function(){
        server();
        expect(mongooseStub.connect).to.be.calledWith(sinon.match.
string);
    });
    it('should launch the app', function(){
        server();
        expect(app.get).to.be.calledWith('port');
        expect(app.listen).to.be.calledWith(3300, sinon.match.func);
    });
});
```

In the preceding group of tests, we are testing the bootstrapping of our server, which is all of the functionalities that initially run within `server.js`. The names of the tests are pretty self-explanatory. We're checking against the various methods of the `app` object, ensuring that they're called and/or the correct parameters were passed in. Notice for the tests we want to test that a specific type of parameter was called but not literally what the parameter value was; we use Sinon's `match` element, which allows our tests to be a little more generic. We wouldn't want to hard code the MongoDB URI string in our tests because that's just another place we would have to maintain—although you could very well do this if you wanted your test to be that strict (that is to assert that quite literally the exact URI string was passed).

In the second set of tests, we want to ensure that the port is set, that it defaults to `3300`, and that it can be changed via the use of a node environment variable:

```
describe('Port', function(){
    it('should be set', function() {
```

```
            server();
            expect(app.set.firstCall.args[0]).to.equal('port');
        });
        it('should default to 3300', function() {
            server();
            expect(app.set.firstCall.args[1]).to.equal(3300);
        });
        it('should be configurable', function() {
            process.env.PORT = '5500';
            server();
            expect(app.set.firstCall.args[1]).to.equal('5500');
        });
    });
```

With these tests in place, run the `npm test` command again and you should get the following output:

```
$ npm test
Server
    Bootstrapping
       should create the app (364ms)
       should set the views
       should configure the app
       should connect with mongoose
       should launch the app
    Port
       should be set
       should default to 3300
       should be configurable
```

Testing a model

When testing our models, we want to include the `model` module itself and then write tests against it. The easiest solution here is that we create a test model object and then assert that the model has all of the fields that we expect, as well as any virtuals we might have created.

Create the file `test/models/image.test.js` and insert the following code:

```
    var ImageModel = require('../../models/image');

    describe('Image Model', function() {
```

```
    var image;

    it('should have a mongoose schema', function(){
        expect(ImageModel.schema).to.be.defined;
    });

    beforeEach(function(){
        image = new ImageModel({
            title: 'Test',
            description: 'Testing',
            filename: 'testfile.jpg'
        });
    });

    // to do: write tests...
});
```

First, we include the `ImageModel` using require (note the path for the require statement). The very first test we run is to make sure that the `ImageModel` has a mongoose schema property. After this test, we define the `beforeEach` block that we'll rely on for the remainder of our tests. Before every test, we want to instantiate a new image model object that we can test against. We do this in a `beforeEach` block so that we're sure we're dealing with a fresh object in every test and that it hasn't been tainted by any tests that were previously run. It's also important to note that the order of the first test and the `beforeEach` block doesn't actually matter, as the `beforeEach` block will run before every test in its parent `describe` function regardless of the order it was defined in.

Include the following suite of tests replacing the placeholder `// to do: write tests...` comment:

```
describe('Schema', function() {
    it('should have a title string', function(){
        expect(image.title).to.be.defined;
    });
    it('should have a description string', function(){
        expect(image.description).to.be.defined;
    });
    it('should have a filename string', function(){
        expect(image.filename).to.be.defined;
    });
    it('should have a views number default to 0', function(){
        expect(image.views).to.be.defined;
```

```
            expect(image.views).to.equal(0);
        });
        it('should have a likes number default to 0', function(){
            expect(image.likes).to.be.defined;
            expect(image.likes).to.equal(0);
        });
        it('should have a timestamp date', function(){
            expect(image.timestamp).to.be.defined;
        });
    });
```

Here, we check to ensure that each property we expect an `ImageModel` instance to have is defined. For the properties that have default values set, we also check to ensure the default values are set as well.

Next, we test against the `virtuals` we expect an `ImageModel` to have, and verify that they function the way they're supposed to:

```
    describe('Virtuals', function(){
        describe('uniqueId', function(){
            it('should be defined', function(){
                expect(image.uniqueId).to.be.defined;
            });
            it('should get filename without extension', function(){
                expect(image.uniqueId).to.equal('testfile');
            });
        });
    });
```

When testing the `uniqueId` virtual, it should return the `image` model's `filename` without the extension. As the `beforeEach` defined our `image` model with a `filename` of `'testfile.jpg'`, we can assert with our test that the `uniqueId` returned is equal to `'testfile'` (the filename without the extension).

Running the tests for our model should output the following results:

```
$ npm test
Image Model
     should have a mongoose schema
    Schema
       should have a title string
       should have a description string
       should have a filename string
```

```
    should have a views number default to 0
    should have a likes number default to 0
    should have a timestamp date
  Virtuals
    uniqueId
      should be defined
      should get filename without extension
```

Testing a controller

Last but not least, let's take a look at the `image` controller, and specifically tests for the main `index` function. Because the index function does a lot of work and performs a number of different tasks, the test file will make extensive use of stubs and spies. The first thing we need to do before any tests is declare a number of global variables for our tests as well as set up all of our stubs, spies, and placeholder objects for use with Proxyquire. Then, we require the actual image controller using Proxyquire. Create a file named `tests/controllers/image.test.js` and insert the following code:

```
var proxyquire = require('proxyquire'),
    callback = sinon.spy(),
    sidebarStub = sinon.stub(),
    fsStub = {},
    pathStub = {},
    md5Stub = {},
    ModelsStub = {
        Image: {
            findOne: sinon.spy()
        },
        Comment: {
            find: sinon.spy()
        }
    },
    image = proxyquire('../../controllers/image', {
        '../helpers/sidebar': sidebarStub,
        '../models': ModelsStub,
        'fs': fsStub,
        'path': pathStub,
        'md5': md5Stub
    }),
    res = {},
    req = {},
    testImage = {};
```

With this code, we define a number of global variables as spies, stubs, or empty placeholder JavaScript objects. Once our stubs are prepared, we call Proxyquire to include our image controller (ensuring that the required modules within the image controller are actually replaced with our various stubs and spies). Now that all of our globals, stubs, and spies are prepared, let's include some tests.

Include the following code after the previous block of code:

```
describe('Image Controller', function(){
    beforeEach(function() {
        res = {
            render: sinon.spy(),
            json: sinon.spy(),
            redirect: sinon.spy()
        };
        req.params = {
            image_id: 'testing'
        };
        testImage = {
            _id: 1,
            title: 'Test Image',
            views: 0,
            likes: 0,
            save: sinon.spy()
        };
    });
    // to do: write tests...
});
```

Once again, we build up some setup using a `beforeEach` block for our tests. This sets spies on each of the `res` object's functions including `render`, `json`, and `redirect` (each of these are used throughout the image controller). We fake the query string parameter by setting the `req.params` object with an `image_id` property. Finally, we create a test image object that will be used by our fake mongoose image model stub to emulate a database object being returned from MongoDB:

```
describe('Index', function(){
    it('should be defined', function(){
        expect(image.index).to.be.defined;
    });
    it('should call Models.Image.findOne', function(){
        ModelsStub.Image.findOne = sinon.spy();
        image.index(req, res);
```

```
            expect(ModelsStub.Image.findOne).to.be.called;
        });
        it('should find Image by parameter id', function(){
            ModelsStub.Image.findOne = sinon.spy();
            image.index(req, res);
            expect(ModelsStub.Image.findOne).to.be.calledWith(
                { filename: { $regex: 'testing' } }, sinon.match.func);
        });
        // to do: write more tests...
    });
```

The first test we run is to ensure that the `index` function actually exists. Within the `index` function, the very first action that occurs is that the image model is found via the `Models.Image.findOne` function. In order to test that function, we need to first set it as a spy. The reason we do this here and not in our `beforeEach` is because we might want the `findOne` method to behave slightly differently per test, so we don't want to set a strict rule to be applied for all the tests.

In order to emulate that a `GET` call was posted to our server and our image index controller function was hit, we can just fire the function manually. We do this using `image.index(req, res)` and pass in our fake request and response objects (defined earlier as globals and stubbed in the `beforeEach` function).

Since `ModelsStub.Image.findOne` is a spy, we can test that it was called, and then separately test that it was called specifically with the parameters we expect it to be called with. In the case of the `findOne` where the second parameter is a callback function, we don't care or want to test the very specific function that was included; only that an actual function was included. To do this, we can use Sinon's matcher API and specify that a `func`, or function, was included as the second parameter.

This last set of tests tests the code that executes when an image is found and returned from the `findOne` function:

```
    describe('with found image model', function() {
        beforeEach(function(){
            ModelsStub.Image.findOne =
                sinon.stub().callsArgWith(1,null,testImage);
        });
        it('should incremement views by 1 and save', function(){
            image.index(req, res);
            expect(testImage.views).to.equal(1);
            expect(testImage.save).to.be.called;
        });
```

```
    it('should find related comments', function(){
        image.index(req, res);
        expect(ModelsStub.Comment.find).to.be.calledWith(
            {image_id: 1},
            {},
            { sort: { 'timestamp': 1 }},
            sinon.match.func
        );
    });
    it('should execute sidebar', function(){
        ModelsStub.Comment.find =
            sinon.stub().callsArgWith(3, null, [1,2,3]);
        image.index(req, res);
        expect(sidebarStub).to.be.calledWith(
            {image: testImage, comments: [1,2,3]}, sinon.match.func);
    });
    it('should render image template with image and comments',
function(){
        ModelsStub.Comment.find =
            sinon.stub().callsArgWith(3, null, [1,2,3]);
        sidebarStub.callsArgWith(1, {image: testImage, comments:
[1,2,3]});
        image.index(req, res);
        expect(res.render).to.be.calledWith('image', {image:
testImage, comments: [1,2,3]});
    });
});
```

The first thing to notice here is that `findOne` is no longer a spy in these tests, but a stub that will manually fire the `callback` function that's provided as its second parameter. The `callback` function that's fired will include our test image model. With this stub, we are emulating that the database call was in fact made via `findOne` and that a valid image model was returned. Then, we can test the remainder of the code that executes within that main callback. We perform a similar setup with the `Comment.find` call as well.

When the `sidebarStub` gets executed, we use the `callsArgWith` Sinon function—which fires the callback function that was originally included as a parameter. Within that callback function, we include the fake `viewModel` as a parameter.

Once the `sidebarStub` does its job, we expect the `res.render` to have been called, and specify the exact parameters we expect it to have been called with.

Running the tests for the image controller should yield the following output:

```
$ npm test
Image Controller
    Index
       should be defined
       should call Models.Image.findOne
       should find Image by parameter id
      with found image model
         should incrememement views by 1 and save
         should find related comments
         should execute sidebar
         should render image template with image and comments
```

Spy and stub everything!

When in doubt, the safest thing you can do when writing your tests is spy on everything and stub everything else. There are always going to be times that you'll want a function to execute naturally; in that case, leave it alone. Ultimately, you never want your tests to be dependent on any other system—that includes database servers, other network servers, other APIs, and so on. You only want to test that your own code works, nothing more. If your code is expected to make a call to an API, spy on the actual call and just assert that your code attempted to make the call. Likewise, fake the response from the server via a stub and ensure that your code handles the response properly.

The easiest way to check for dependencies in your code is to stop any other services from running (your local node app, and so on), as well as possibly even disabling your network connection. If your tests timeout or fail somewhere unexpectedly, it's likely because you missed a function you needed to spy on or stub along the way.

Don't get stuck going down a rabbit hole when writing your tests. It's easy to get carried away and start testing functionalities that should safely be assumed works. An example of this is writing tests to ensure a third-party module is performing correctly. If it's not a module you wrote, don't test it. Test that your code uses it properly, makes calls to it with the correct parameters, and handles any returns, but don't worry about writing tests to prove the module does what it says it should.

To learn more about TDD specifically when writing JavaScript, I would highly recommend Christian Johansen's beast of a book *Test-Driven JavaScript Development*. This book is huge and speaks to the sheer volume of information related to TDD. In some circles, TDD truly is a way of life and it will define the style with which you write your code.

Summary

This has definitely been a crash course on testing, but the groundwork has been laid and I hope that you have a solid understanding of the tool chain that you can use to write your own tests. We installed the Mocha test framework and wrote our first tests for Node.js. Using a custom `testhelper.js` file, we integrated the various libraries and frameworks necessary to write tests for our code. These tools included Chai.js to write our assertions and Sinon.js for our spies and stubs. Trust this powerhouse suite of tools and you'll be writing bulletproof code in no time!

The ultimate goal with writing tests is to have 100 percent complete code coverage and have unit tests exist for every line of code you write. From here, the true test is to switch to TDD, which dictates that you write tests before any code exists at all. Obviously, tests against nonexistent code will fail, so then you'll need to write the least amount of code to get it to pass, and repeat!

In the next chapter, we'll take a look at a number of cloud-based hosting options available to get your application up and running online.

10
Deploying with Cloud-based Services

Inevitably, you'll want the application you've been building to be online and available to the world—whether you want to host your application online during its development process or whether it's complete and ready for production. There are a number of different hosting options currently available for Node.js- and MongoDB-based apps, and in this chapter, we'll take a look at deploying to a few different popular services.

In this chapter, we will cover:

- Cloud versus traditional web hosting
- Introduction to Git source control
- Deploying an application with Nodejitsu
- Deploying an application with Heroku
- Deploying an application with Amazon Web Services
- Deploying an application with Microsoft Azure
- A brief look at Digital Ocean

Cloud versus traditional hosting

If you have had any previous experience with website hosting in the past, which I'll refer to as traditional hosting, you're probably pretty familiar with the process of using FTP to upload your web files to your hosting provider. With traditional web hosting, service providers typically offer shared space to every user, each configured with their own *public* folder that houses the web files. In a scenario like this, every customer is hosting the same kind of website, and their files are all stored and served from a single web server.

Traditional web hosting is fairly inexpensive because a single web server can host literally hundreds, if not thousands, of individual websites. Scaling is typically a problem with traditional hosting because if your website demanded more power, it would need to be moved to another server (with more hardware) and could experience potential downtime during this move. As a side effect, if a website on the same server as your own is being particularly demanding of the hardware, every site on that server could suffer.

With cloud-based hosting, every instance of a website or service is hosted on its own **Virtual Private Server** (**VPS**). When a customer uploads a copy of their website, that website is running in its own isolated environment, and the environment is specifically designed to run only that website. Virtual private servers are instances of a server, typically all running simultaneously on the same hardware. Because of their isolated nature, VPS scales very well because settings simply need to be changed for hardware allocation and the server restarts. If your VPS is hosted on the same hardware as others, and they are experiencing high-volume spikes, your website will not suffer because of the isolated nature of the VPS.

Infrastructure as a Service (IaaS) versus Platform as a Service (PaaS)

The beauty of the cloud is that the level and amount of service one can obtain varies greatly. From something as simple as a basic hosting plan to run your web application, you can use any number of services that are considered a **Platform as a Service** (**PaaS**). This is a service that provides a platform for you to host and run your web application. Increasing in scale and complexity, you can turn to an **Infrastructure as a Service** (**IaaS**) provider, which offers an entire cloud-based data center at your disposal.

You can learn more about the differences between IaaS, PaaS, and **Software as a Service** (**SaaS**) by reading this detailed article at:

`http://www.rackspace.com/knowledge_center/whitepaper/understanding-the-cloud-computing-stack-saas-paas-iaas`

Cloud-based hosting costs can vary greatly because of the simple fact that they are so scalable. Your costs could fluctuate throughout a single month dramatically depending directly on your need for power (that is more demanding times of the month and/or big social media hits such as HackerNews or Reddit). On the flip side, if you require very little power for a server, often you can get cloud hosting for free!

Traditional web hosting service providers include GoDaddy, Dreamhost, 1&1, HostGator, and Network Solutions. Popular cloud-based hosting options include Nodejitsu (PaaS), Heroku (PaaS), Amazon Web Services (IaaS), Microsoft Azure (IaaS), and Digital Ocean.

Introduction to Git

With traditional hosting providers, the standard method for connecting to your server and uploading your files was to use **File Transfer Protocol** (**FTP**). You would connect using any standard FTP software and push a copy of your files to the server and those changes would be reflected instantly online when accessing your website URL. With cloud-based hosting providers, the standard typically is to use the Git source control. Git is a source control technology that allows you to track changes and history with your project source code as well as provide an easy-use means of collaboration with multiple developers. The most popular Git online code repository provider currently is `www.GitHub.com`.

For the purposes of this chapter, we are going to use Git in order to track our application project source code as well as the method of pushing our code up to the various cloud-hosting providers. When you push code using Git, you are effectively transferring all or only the changed version of your code to an online repository (like `www.GitHub.com`).

Git and `www.GitHub.com` are both topics that are relatively easy to get into but can seem intimidating and complex. If you're unfamiliar with Git and/or GitHub.com, I would strongly suggest taking a moment to get acquainted by checking out the following guides:

- `https://help.github.com/articles/set-up-git`
- `http://lifehacker.com/5983680/how-the-heck-do-i-use-github`

The guides will take you through the following concepts:

- Downloading and installing Git
- Registering an account at `www.GitHub.com`
- Authenticating your machine with `www.GitHub.com`
- Creating your first repository
- Committing your project source code to the repository

Once you have your project source code configured as a local Git repository and all of the code committed to the `master` branch, proceed to the following sections.

Deploying your application

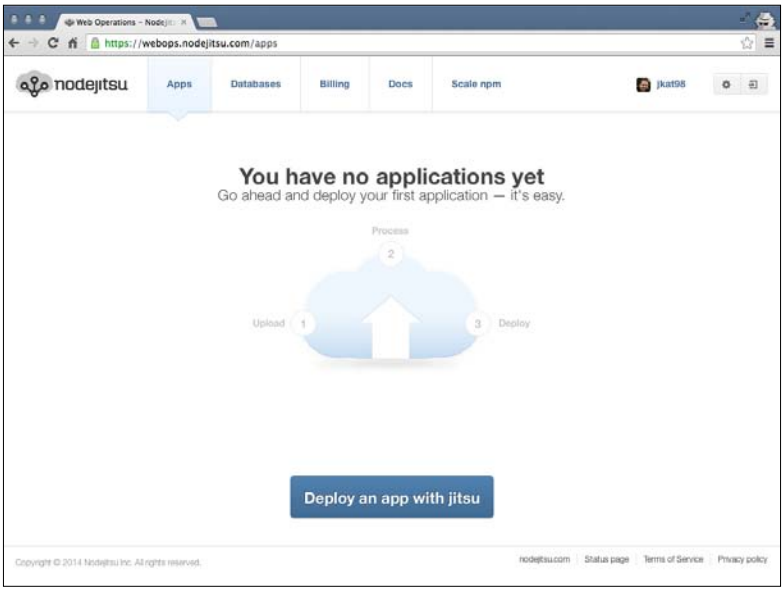
Now that you have your project set up as a local GitHub repository, its time to take that code and get it online! The following sections will each cover the process of deploying your application to a few different popular cloud-based hosting providers.

Feel free to explore and experiment with each as most have free or relatively inexpensive plans. Each provider has its strengths and weaknesses, so I'll leave it up to you to decide which to stick with for your particular needs. The services that we cover aren't presented in any particular order.

Note that for the purposes of this chapter, I will consistently name my app `imgploadr`; however, your app name needs to be different and unique. Wherever I include `imgploadr` in this chapter, you should replace it with your own app's unique name.

Nodejitsu

To get started with Nodejitsu, first visit `http://nodejitsu.com` and register for a free account. After providing your e-mail address, username, and password, you will be presented with a pricing plan page where you can configure your service. If you just want to create the free account and experiment, simply click on the **No Thanks** button and the registration process is complete. Once you're finished, simply click on the **Login** button in the upper right corner to log in and proceed to your **Apps** dashboard:



Deploying your app to Nodejitsu is going to require a new command-line interface tool, specifically, the `jitsu` CLI. Clicking on the big blue **Deploy an app with jitsu** button will take you to the `www.github.com` repository for this tool. You can skip that step and just install the CLI manually using the following npm command:

```
$ sudo npm install -g jitsu
```

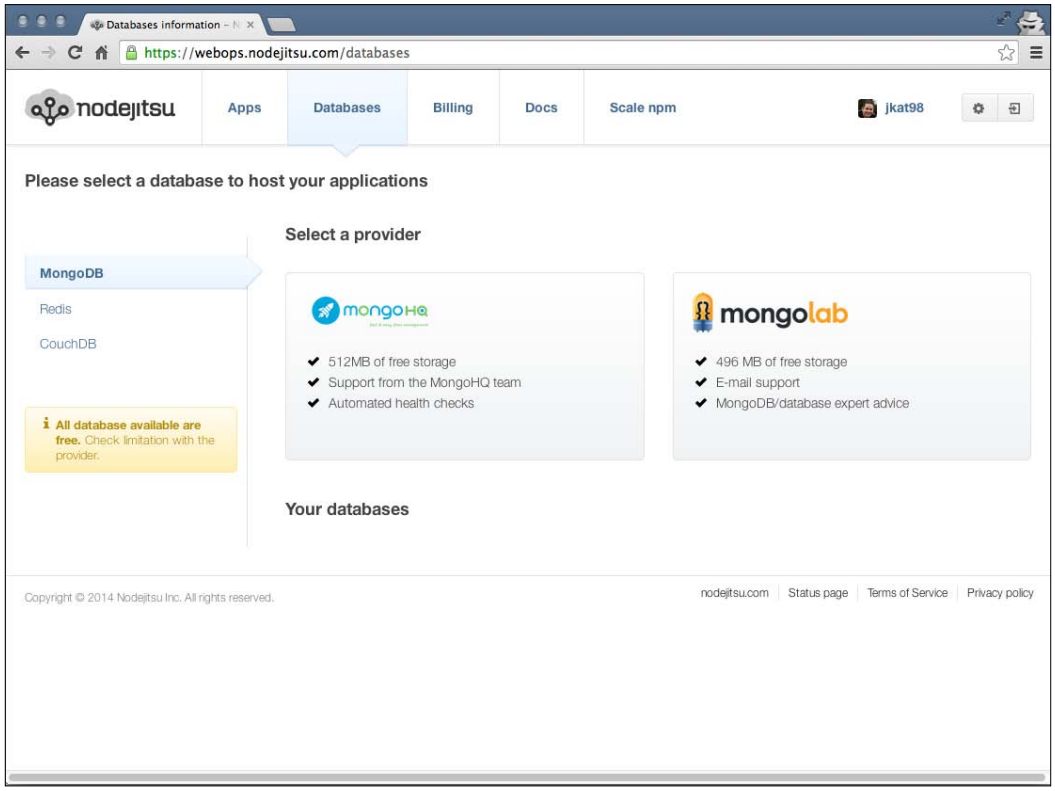
Note that the `sudo` part of the command to install an npm package globally (using the `-g` flag) is sometimes required. Depending on your access level of the machine you are using, you may or may not need to include `sudo`.

Now that the `jitsu` CLI is installed, you can use this handy tool to log in to your Nodejitsu account, create an app, and deploy your project code. First, let's log in:

```
$ jitsu login
info:    Welcome to Nodejitsu
info:    jitsu v0.13.18, node v0.10.26
info:    It worked if it ends with Nodejitsu ok
info:    Executing command login
help:    An activated nodejitsu account is required to login
help:    To create a new account use the jitsu signup command
prompt: username:  jkat98
prompt: password:
info:    Authenticated as jkat98
info:    Nodejitsu ok
```

You can see that after successfully providing your username and password, you are now authenticated with Nodejitsu and ready to go.

Before we can deploy the actual application, we need to first configure the MongoDB database in our Nodejitsu dashboard. Switch back to your browser, and on the Nodejitsu **Apps** dashboard, switch sections by clicking on the **Databases** tab:



Let's choose MongoHQ for our needs, so click on the large MongoHQ button. You will be prompted for a name for the new database and then it will be listed at the bottom of the screen in the **Your databases** section. The important part we need is the connection string, and there's a convenient copy link right next to it to copy it to your clipboard.

Edit the `server.js` file and update the `mongoose.connect` line to use this new connection string you copied for your Nodejitsu database:

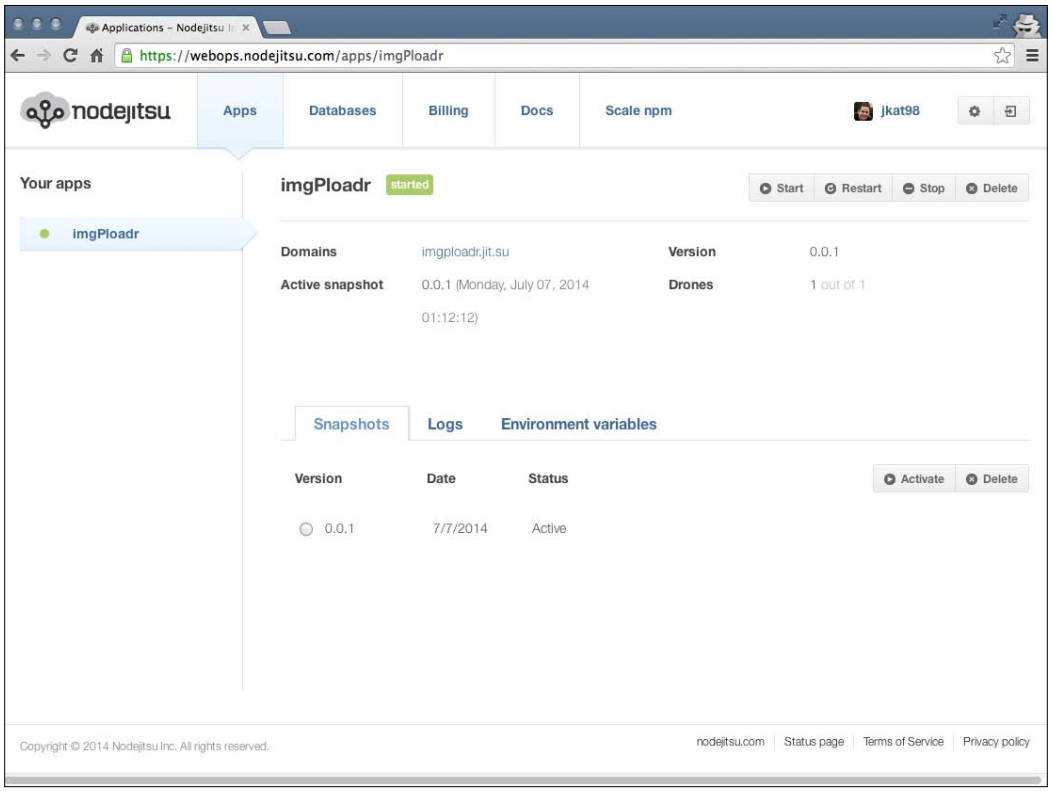
```
[/server.js]
mongoose.connect('YOUR_NODEJITSU_CONNECTION_STRING_HERE');
mongoose.connection.on('open', function() {
    console.log('Mongoose connected.');
});
```

The only thing left remaining is to open a terminal, change directories to your project home, and execute the following command to package up your app and push it to Nodejitsu:

```
$ jitsu deploy
info:    Welcome to Nodejitsu jkat98
info:    jitsu v0.13.18, node v0.10.26
info:    It worked if it ends with Nodejitsu ok
info:    Executing command deploy
warn:
warn:    The package.json file is missing required fields:
warn:
warn:      Subdomain name
warn:
warn:    Prompting user for required fields.
warn:    Press ^C at any time to quit.
warn:
prompt: Subdomain name:  (jkat98-imgploadr) imgploadr
warn:    About to write /Users/jasonk/repos/nodebook/imgploadr/package.
json
... (a lot of npm install output) ...
info:    Done creating snapshot 0.0.1
info:    Updating app myapp
info:    Activating snapshot 0.0.1 for myapp
info:    Starting app myapp
info:    App myapp is now started
info:    http://imgploadr.nodejitsu.com on Port 80
info:    Nodejitsu ok
```

After executing `jitsu deploy`, the CLI first prompts to confirm what the subdomain will be under the `www.nodejitsu.com` domain. Feel free to change this to whatever you like (it will check to confirm availability). It will then make a few minor modifications to your `package.json` file, specifically including the `subdomain` option with whatever value you provided. Finally, it uploads your source code and performs a remote `npm install` operation. Assuming all went well, the app should be deployed and a confirmation of the URL outputs to the screen. Feel free to open that URL in your browser to view the app online!

You can also now see that the app is listed in your **Apps** dashboard:



Now that the application has been successfully uploaded, launch it via its URL and give it a test run by attempting to upload a new image. The first thing you should notice is that attempting to upload an image fails with a fairly useless error (you can see the following error by accessing the **Logs** tab from your app's dashboard):

```
400 Error: ENOENT, open '/opt/run/snapshot/package/public/upload/
temp/72118-89rld0.png
```

This error is far from helpful! Basically, what's happening here is that the application is attempting to upload and save the image to the `temp` folder that doesn't actually exist! We need to add a snippet of code to our application to check for this condition and create the folders if necessary.

Edit the `server/configure.js` file and insert the following snippet of code right between `routes.initialize(app);` and `return app;`:

```
// Ensure the temporary upload folders exist
fs.exists(path.join(__dirname, '../public/upload/temp'),
function(exist) {
    if (!exist) {
        fs.mkdir(path.join(__dirname, '../public/upload'),
function(err){
            console.log(err);
            fs.mkdir(path.join(__dirname, '../public/upload/temp'),
                function(err){
                    console.log(err);
                });
        });
    }
});
```

Here we're using the filesystem `fs` module to check whether the `upload/temp` folder exists, and if not, create both the parent `upload` folder as well as the `temp` subfolder. Don't forget to require the `fs` module at the top of the file too:

```
var connect = require('connect'),
    path = require('path'),
    routes = require('./routes'),
    exphbs = require('express3-handlebars'),
    moment = require('moment'),
    fs = require('fs');
```

There is an npm module called `node-mkdirp` that will perform a recursive `mkdir`, which basically would accomplish the double `mkdir` we called in the preceding example. The only reason I didn't include it was for brevity and to not unnecessarily include additional instructions to install the module, require it, and use it. More info can be found at `https://www.npmjs.org/package/mkdirp`.

With the mentioned changes made to your code, you need to deploy your application again. Simply execute another `jitsu deploy` and a fresh copy of your code will be uploaded to your instance:

```
$ jitsu deploy
```

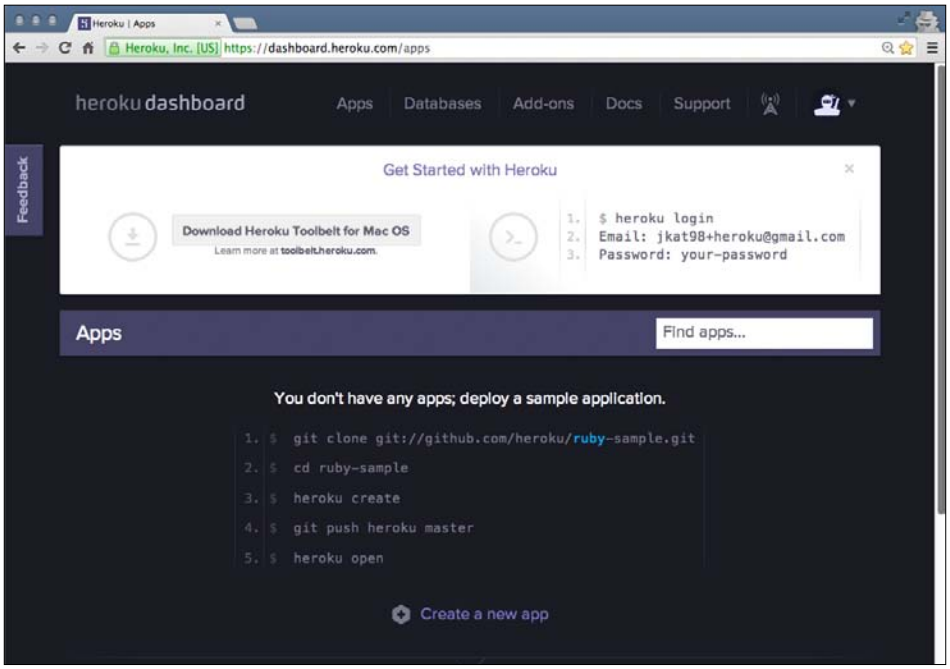
Open your app URL again, and this time you should be able to interact with the application and successfully upload a new image! Congratulations, you have successfully deployed your application and it is now online using the Nodejitsu hosting service!

Heroku

Another popular cloud-based hosting provider for Node.js apps is `www.Heroku.com`. The one thing that sets Heroku apart from other providers is the number of powerful add-ons that are available. Any kind of service you can imagine your application requiring is available as an add-on, including data stores, search, logging and analytics, e-mail and SMS, workers and queuing, monitoring, and media! Each of these add-ons can be quickly and easily added to your service and integrated into your application with ease.

Like Nodejitsu, Heroku allows you to register a free account and work within the confines of their "sandbox" pricing plans. The plans are free, but limited in scope with regard to bandwidth, processing power, and so on. Most, if not all, of the add-ons typically also offer some sort of free sandbox- or trial-based plan. Just like Nodejitsu, one of the add-ons we will be using with our Heroku app is MongoHQ, a cloud-based MongoDB service provider.

To get started, first go to `http://heroku.com` and sign up for your free account. While registration doesn't require a credit card, in order to include any add-ons with your application, you will have to have a credit card on file (even though it won't be charged unless you choose to scale up the services). After registering, clicking on the link in the confirmation e-mail and providing a password, you will be presented with your **Apps** dashboard:



You'll notice that the first thing you need to do is download the Heroku Toolbelt (again, much like the `jitsu` CLI for Nodejitsu). Click on the download button to download and install the toolbelt. The toolbelt is a CLI, specifically to create and deploy apps to Heroku and gives you the `heroku` command.

Once you have the toolbelt installed, open a command-line terminal and change directories to your project's root. From there, execute the following command to log in to Heroku:

```
$ heroku login
Enter your Heroku credentials.
Email: jkat98@gmail.com
Password (typing will be hidden):
Authentication successful.
```

Now that you're logged in you can issue commands directly to your Heroku account and use those commands to create an application, install add-ons, and deploy your project.

The first thing you'll want to do is create a new application. Do so by executing `heroku create` from the command line:

```
$ heroku create
Creating secret-shore-2839... done, stack is cedar
http://secret-shore-2839.herokuapp.com/ | git@heroku.com:secret-
shore-2839.git
```

After creating the app, Heroku randomly assigned it a unique name; in my case, `secret-shore-2839` (don't worry though as this can easily be changed):

```
$ heroku apps:rename imgploadr --app secret-shore-2839
Renaming secret-shore-2839 to imgploadr... done
http://imgploadr.herokuapp.com/ | git@heroku.com:imgploadr.git
Don't forget to update your Git remotes on any local checkouts.
```

Let's address that last part next. Heroku relies on the Git source control on your machine in order to push your project source code up to your server, unlike Nodejitsu, which uses its own file transfer mechanism. Assuming you followed the directions earlier with regard to Git and `www.GitHub.com`, your project source code should be all set and committed to the master branch and ready to go. What we need to do next is add a new remote for Git on your machine to point to Heroku and specifically your new app.

Execute the following command to create a new remote for Heroku:

```
$ git remote add heroku git@heroku.com:imgploadr.git
```

Before you can push your source code up to your Heroku account, we need to take care of a few things first.

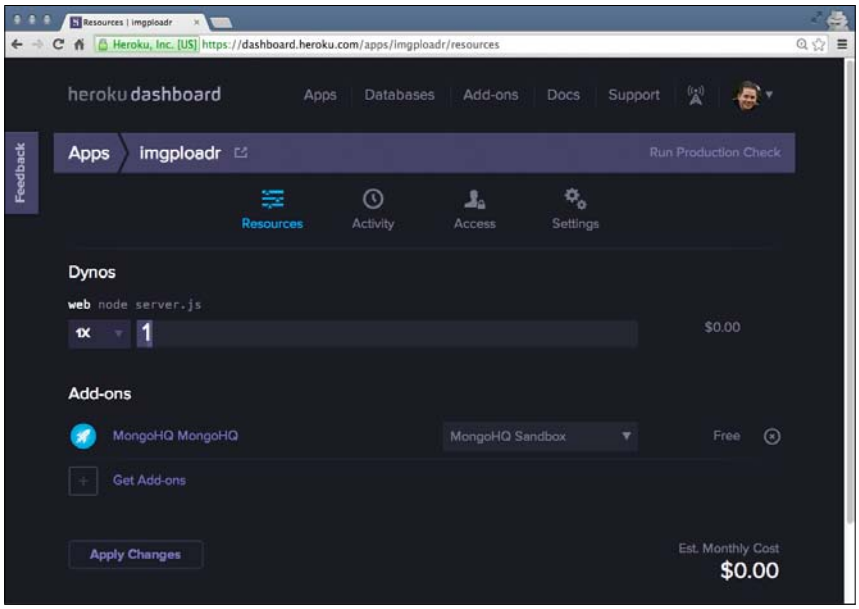
A special file is required before your application will be able to run on your Heroku server. This file is called `Procfile`, and it specifically contains the command necessary to launch your application. Create this new file named `Procfile` (no extension) in the root of your project and include the following line:

```
web: node server.js
```

That's it! With that file, Heroku will use that command to launch your application. Now that you have `Procfile` set up and your project source code ready, there's only one thing left to do—install the MongoHQ add-on and configure your app to use it:

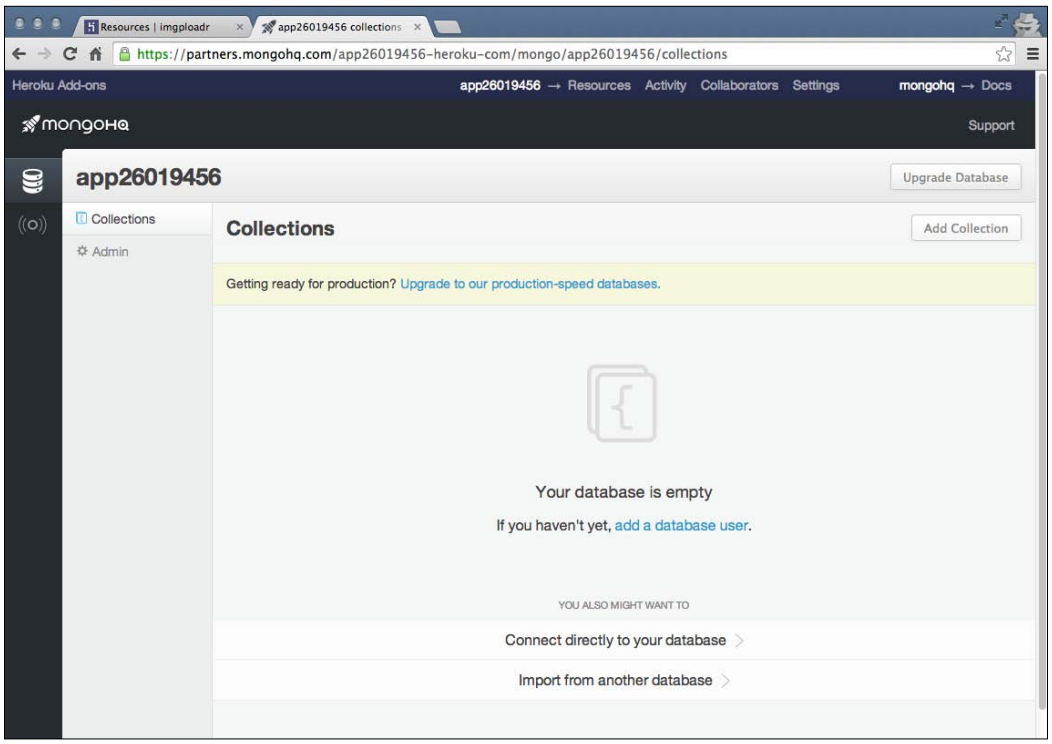
```
$ heroku addons:add mongohq --app imgploadr
Adding mongohq on imgploadr... done, v3 (free)
Use 'heroku addons:docs mongohq' to view documentation.
```

With the MongoHQ add-on added, you can now configure the database itself and retrieve the connection string (much like you did earlier with Nodejitsu). Access your `http://heroku.com` **Apps** dashboard, and it should look something like the following screenshot:



The app's dashboard screen is a great place to get a snapshot of your application and a quick glance at its current cost. Since I'm using the sandbox and/or free plans for my application and add-ons, my current estimated monthly cost is $0.00. However, you can quickly and easily scale your apps should you demand more power. Pay attention, as you can also just as quickly and easily escalate your monthly cost through the roof! (Scaling everything to maximum, I was able to get my estimated cost to roughly $60,000 per month!)

To configure your MongoHQ database, simply click on the MongoHQ link under the **Add-ons** section of your app's dashboard:



Click on the **Admin** tab with the gear icon below the **Collections** tab. Click on the **Users** tab and provide a username and password that your application will use to connect with your MongoHQ database. I'll create the `imgploadrdb` username with a secure password. With the new user added, switch back to the **Overview** tab and copy the Mongo URI string.

Again, just like with Nodejitsu, edit the `server.js` file in your project and replace the `mongoose.connect` string with the new URI you just copied. Edit the string and replace `<username>` and `<password>` with the appropriate values based on the new user account you just created. The `server.js` `mongoose.connect` code should look like the following:

```
mongoose.connect('mongodb://imgploadrdb:password@kahana.mongohq.
com:10089/app26');
mongoose.connection.on('open', function() {
    console.log('Mongoose connected.');
});
```

Since you just made changes to your project's source code, you need to remember to commit those changes to your Git repository master branch so that they can get uploaded to Heroku. Execute the following command to permanently commit these changes to your source code and upload your code to your Heroku server:

```
$ git commit -am "Update mongoose connection string"
$ git push heroku master
Initializing repository, done.
Counting objects: 50, done.
Delta compression using up to 8 threads.
Compressing objects: 100% (43/43), done.
Writing objects: 100% (50/50), 182.80 KiB | 0 bytes/s, done.
Total 50 (delta 3), reused 0 (delta 0)
... npm install output ...
To git@heroku.com:imgploadr.git
 * [new branch]      master -> master
```

The final step to get your application up and running is to create an instance of your server (basically the equivalent of turning it on). To do this, execute the following command:

```
$ heroku ps:scale web=1 --app imgploadr
Scaling dynos... done, now running web at 1:1X.
$ heroku open
Opening imgploadr... done
```

Success! Hopefully, your browser launched and your website is up and running. Go ahead, give it a try and upload an image! Thanks to the bug we caught during the Nodejitsu deployment, this updated version of the application should work just fine.

While deploying with Heroku seems more complicated than Nodejitsu, this is probably because it uses Git source control to facilitate the transfer of your project files. Also, because Heroku is so flexible with the power of its scaling and add-ons, the toolbelt CLI is a little more robust.

Amazon Web Services (AWS)

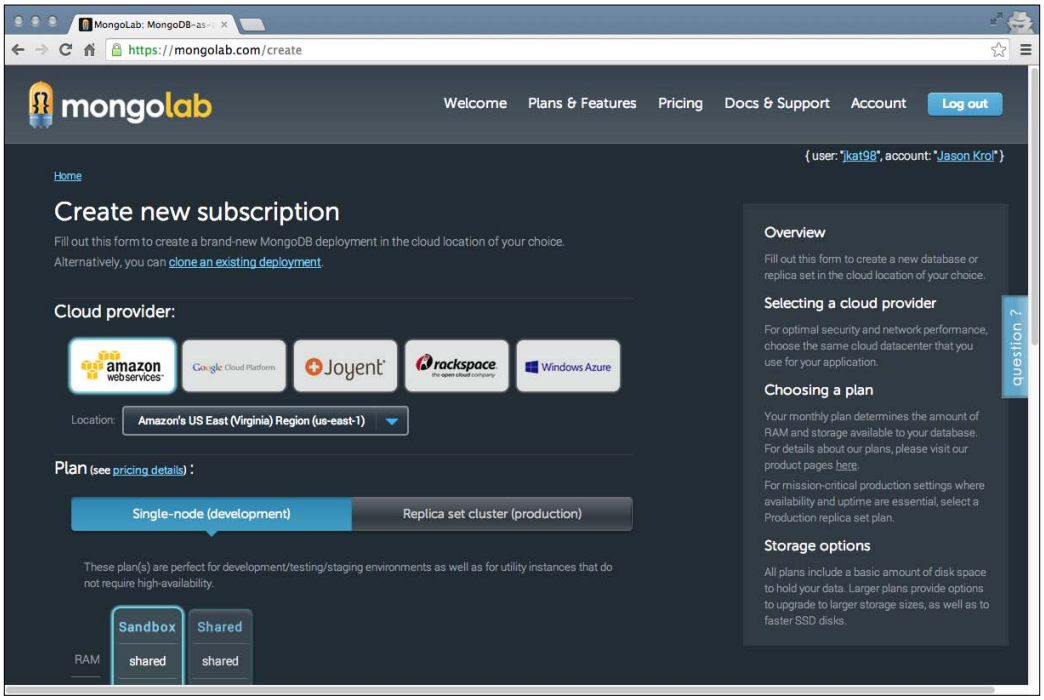
While Nodejitsu and Heroku can be considered developer-level service providers because they are Platforms as a Service, **Amazon Web Services** (**AWS**) (and Microsoft Azure) would be considered enterprise-level services because they are more Infrastructure as a Service. The sheer volume of options and services available with AWS and Azure is staggering. These are definitely top-tier services and hosting an application like ours is kind of like using a bazooka to kill a fly!

AWS does provide its own NoSQL database called DynamoDB, but for our purposes, we want to continue to work with MongoDB and use Mongoose in our app. To do this, we can use a third-party MongoDB provider. If you recall, when we originally set up Nodejitsu, one of the MongoDB providers listed was MongoLab. MongoLab provides "MongoDB-as-a-Service", which means we can use their service to host our MongoDB database, but use all of the power of AWS to host our Node.js application (this is not unlike what's already happening with Nodejitsu and Heroku already—they just streamline the process a little better). Remember that AWS is an Infrastructure as a Service provider, so you could also just create another server instance and install MongoDB on it yourself and use that as your data source. That's slightly beyond the scope of this chapter however.

Create a MongoLab account and database

In order to use MongoLab with our app in AWS, we first need to register a new account on `http://mongolab.com` and create an AWS database subscription. After you register a new account and activate it using the link they send you via e-mail, you can create your first database subscription.

From your main dashboard, click on the **Create new** button (with the lightning bolt icon):



From the **Create new subscription** page, configure the following settings:

- **Cloud provider**: `amazon web services`
- **Location**: (whichever region you prefer)
- **Plan**: Select **Single-node (development)**
    - Sandbox (shared/free)
- **MongoDB version**: `2.4.x`
- **Database name**: `anything_you_want` (I chose: `imgploadr`)
- Confirm that the price is $0 per month
- Click on **Create new MongoDB deployment**

Back at your main dashboard, you should now see that your new database has been created and is ready to go. The next thing we need to do is create a user account that our app will use to connect to the server. Click on the database listed on the main dashboard and then select the **Users** tab. Provide a new username and password. After the new user account has been added, copy the URI located at the top of the screen (it only appears after a user has been added) that starts with `mongodb://`.

Now that you have the new URI connection string, we need to update `server.js` to include this new connection string in our `mongoose.connect`. Edit the file and update the following code:

```
mongoose.connect('mongodb://imgploadrdb:password@ds061248.mongolab.
com:61248/imgploadr');
mongoose.connection.on('open', function() {
    console.log('Mongoose connected.');
});
```

Make sure to replace `<username>` and `<password>` with the appropriate information from the user account you created on the MongoLab dashboard.

With our application code updated to point to the new MongoLab database connection string, we need to zip up the project files so that they can be uploaded via the AWS dashboard. From your computer's file browser, locate the project root that contains all of your applications' source code files, select all of them and right-click on them to add to an archive or ZIP file. The name of the ZIP file can be whatever you choose. One thing to note is that you shouldn't include the `node_modules` folder with this ZIP file (the easiest solution might be to simply delete the folder altogether). The AWS online docs has a great write-up on creating ZIP files if you need more information:

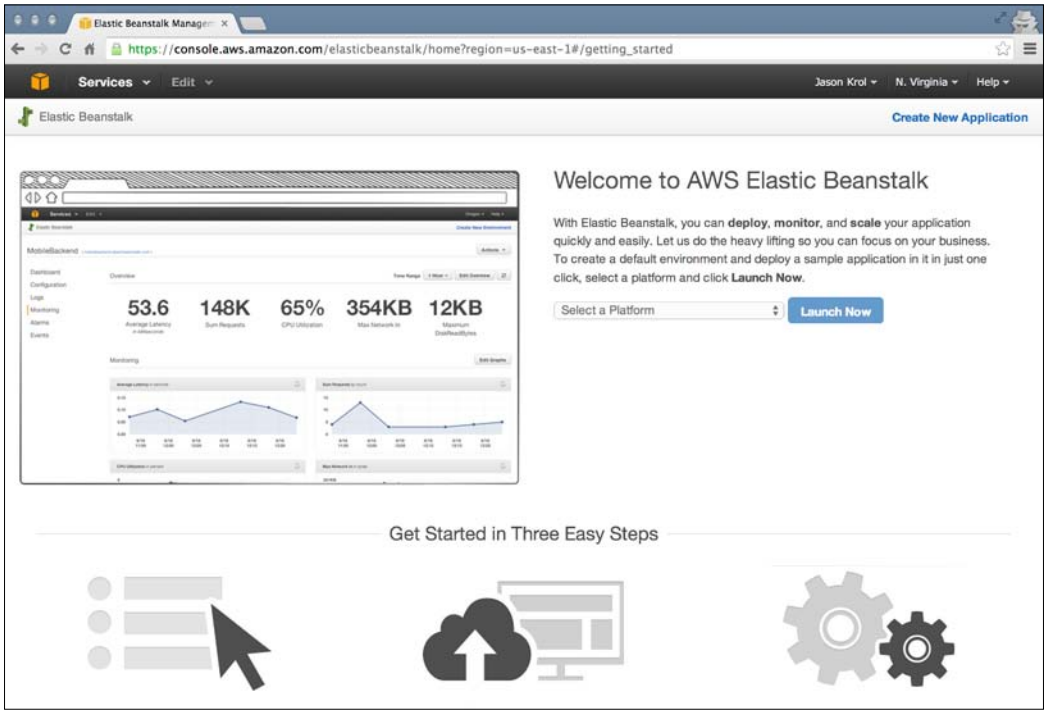
`https://docs.aws.amazon.com/elasticbeanstalk/latest/dg/using-features.deployment.source.html`

Once your source code has been updated to use the new MongoLab connection string and you've created a ZIP file of the entire project (excluding the `node_modules` folder), you're ready to create the new AWS application and deploy your app.

Create and configure the AWS environment

If you don't already have an account with Amazon, you're going to need one to use their AWS services. Point your browser to `http://aws.amazon.com` and click on **Sign Up** (even if you already have an Amazon account). From the screen that follows, you can log in using your existing Amazon account or register for a new account. Once you've registered and logged in, you should be presented with the entire suite of cloud services AWS has to offer.

The primary service we're interested in is Elastic Beanstalk (located under **Deployment and Managed** with a green icon):

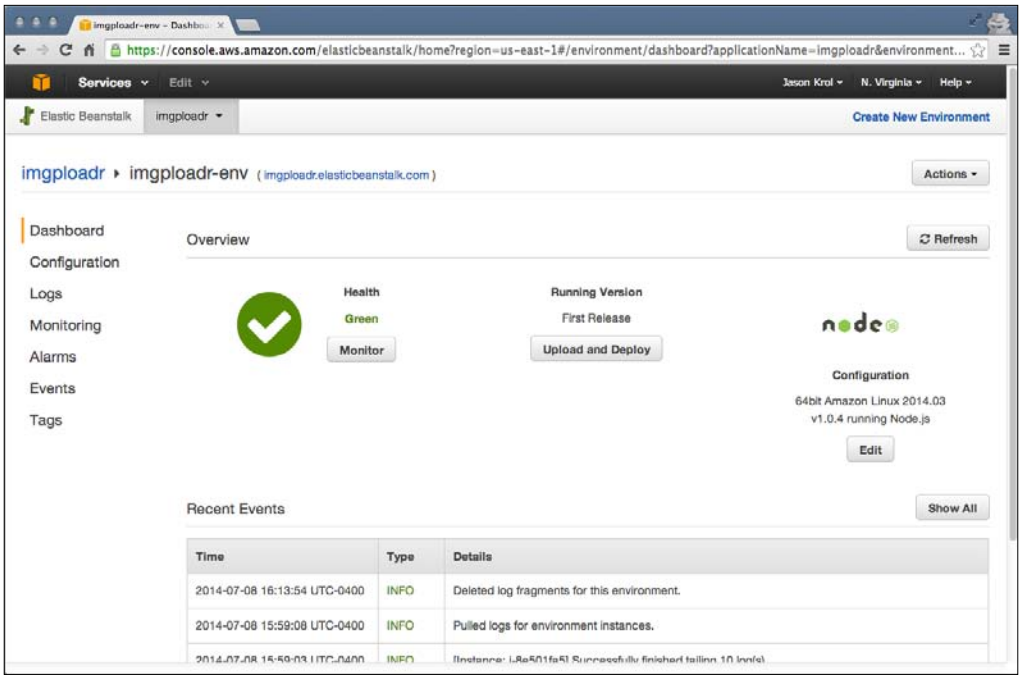


From this screen, click on the **Create New Application** link in the upper right corner. The screens that follow will walk you through a multistep wizard process where you will configure the environment in which the application will reside. Configure the following settings where appropriate:

- **Application Information**:
  - **Application name**: `anything_you_want`
- **Environment Type**:
  - **Environment tier**: `Web Server`
  - **Predefined configuration**: `Node.js`
  - **Environment type**: `Load balancing, autoscaling`
- **Application Version**:
  - Upload your own (choose the ZIP file that you created earlier)

- **Environment Information**:
  - **Environment name**: `anything_you_want`
  - **Environment URL**: `anythingyouwant` (this is the subdomain for your app)
- **Configuration Details**:
  - **Instance type**: `t1.micro`
  - The remaining fields can be left blank or at their default values
- **Environment Tags**:
  - (skip this step—unnecessary for this app)

The final step is to review the configuration settings and then launch the environment (by clicking the blue **Launch** button). It may take a few minutes for Elastic Beanstalk to configure and launch your environment and application so you might need to sit tight:

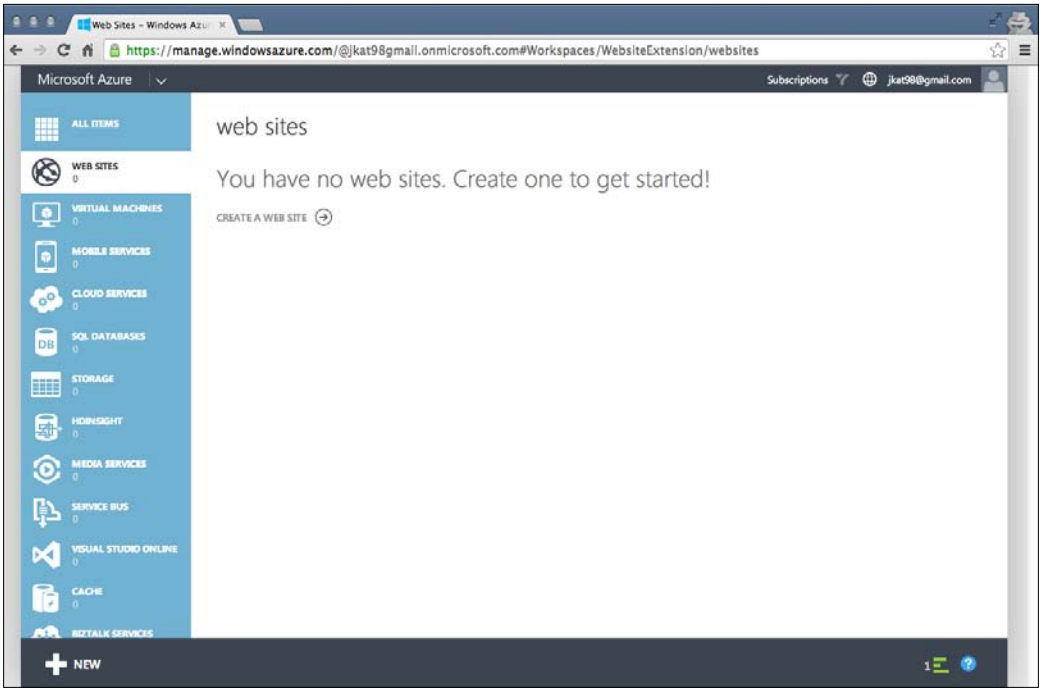


With the environment officially launched and the application online, go ahead and open your app (by clicking the link at the top of the page) and give it a test run. Assuming everything went according to plan, your application should be up and running and working just fine!

Microsoft Azure

Microsoft's Azure service is very similar to Amazon's AWS. Both can be considered enterprise-level services and both offer a tremendous level of flexibility and power with a really slick UI. Surprisingly, even though it's a Microsoft product, you can spin up instances of Linux environments using Azure as well host your Node.js and MongoDB apps!

The first thing you're going to need, like any other service, is a registered account at `http://azure.microsoft.com`. You can use an existing Microsoft Live Login if you have one, otherwise you can register a new account fairly easily. Once you're logged into the Azure service, the first thing you'll be presented with is your primary dashboard. The icons to the left are all of the various services and options available with Azure:



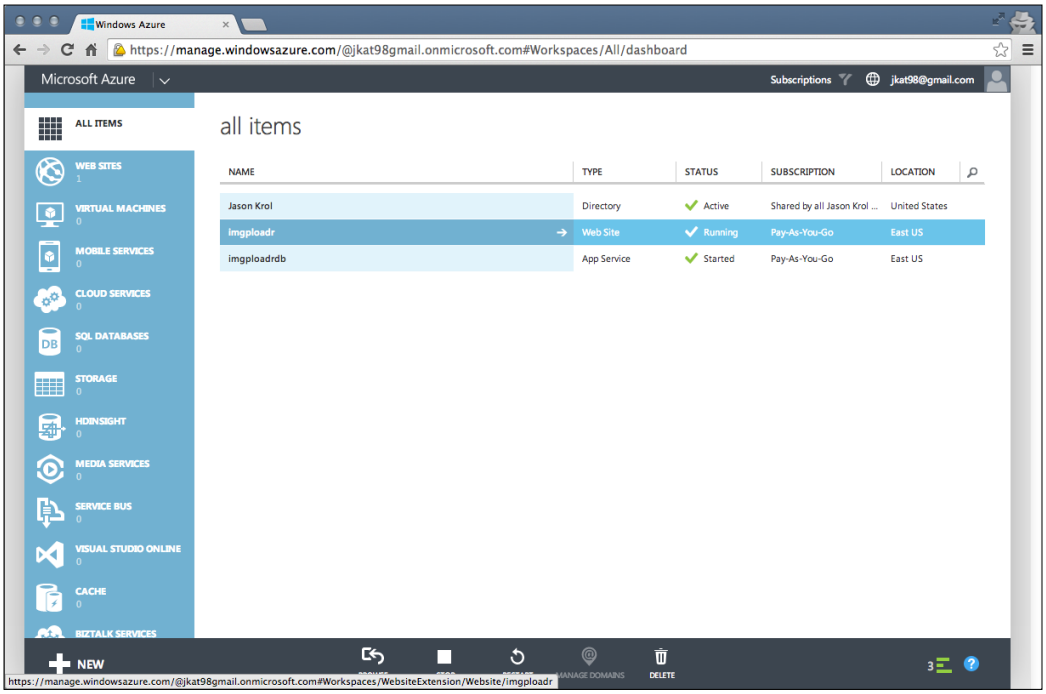
Clicking the **+NEW** icon at the bottom-left corner will present you with the main dialog you can use to add any new service. For our purposes, we want to add a website:

1. Select **Compute**, **Web Site**, and **From Gallery**.
2. Select **Node JS Empty Site** from the long list of gallery options. This will create the necessary environment so that you have somewhere you can put your application.
3. On the screen that follows, provide the URL for your app.
4. Leave the remaining fields as their default values.
5. Click on the checkmark icon to complete the setup process, and your website will be created.

The next step we need to do is set up the database server. Again, very similar to AWS or Nodejitsu, we are going to once again select MongoLab as our database service provider:

1. Click on the **+NEW** icon again and select **Store** and browse the list until you find and select **MongoLab**.
2. Click on the **next** arrow and browse through the various plans. For our needs, we will leave **Sandbox** selected (since it's free).
3. Provide a name for your database; in my case, I entered `imgploadrdb`.
4. Click **next** again to review and confirm the plan and monthly price (should be 0.00 per month).
5. Finally, click on the checkmark icon to **Purchase** this new subscription plan.

After a few seconds, you should be taken back to your dashboard where you will see entries for both the website and database app service listed:



Now that the database has been created and is ready, we need to include its connection string in our application before we can upload our code:

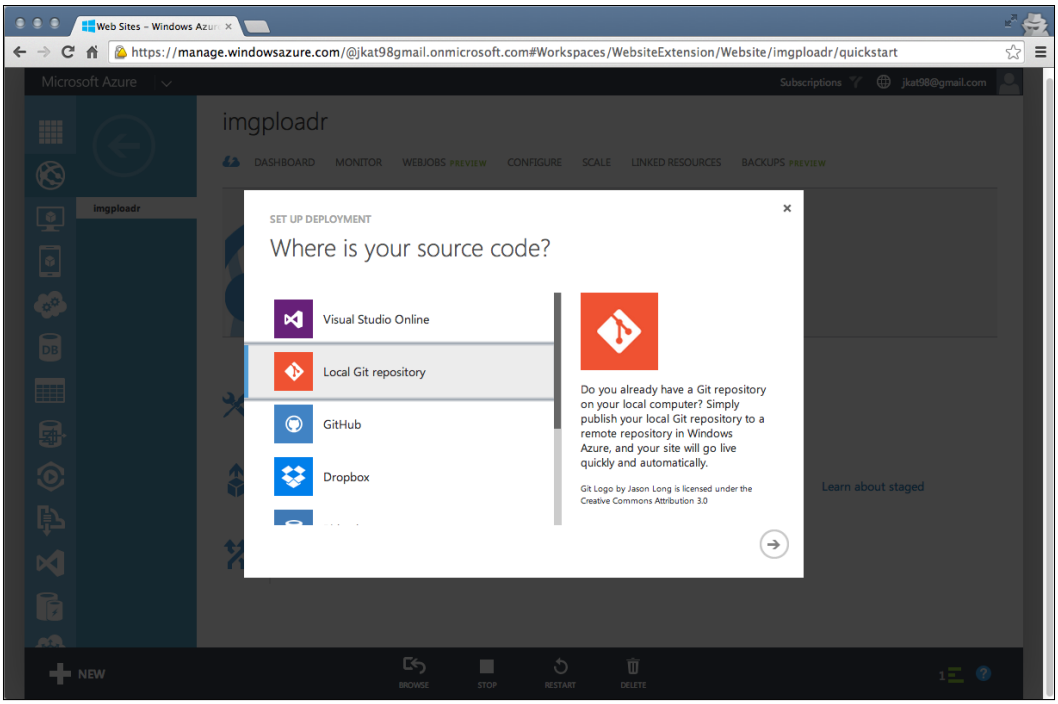
1. Click the database row to select it and go to its overview.
2. The bottom of this screen will contain a few icons, one of which is labeled **Connection Info** (and has an icon that looks like **>i**). Click on that icon to pop up a modal window that contains the connection string URI for your new MongoLab database server.
3. Copy that URI to your clipboard.
4. Edit `server.js` in your local app and replace the `mongoose.connect` connection string with the new string you just copied. No need to update `username` and `password` as Azure has already taken care of this for you:

```
mongoose.connect('mongodb://your_specific_azure_mongolab_uri');
mongoose.connection.on('open', function() {
    console.log('Mongoose connected.');
});
```

Once that change has been made, save the file and don't forget to update your local Git repository with the change, as we'll be using Git in the next section to push your code to Azure (just like we did earlier with Heroku):

```
$ git commit -am "Azure connection string"
```

Back at the Azure dashboard, click on the **Web Site** in **All Items list** (or filter by websites using the icons on the left toolbar). From this overview screen, locate the **Integrate source control** section towards the bottom and click on the **Set up deployment from source control** link. The following screenshot shows what you should see at this point:

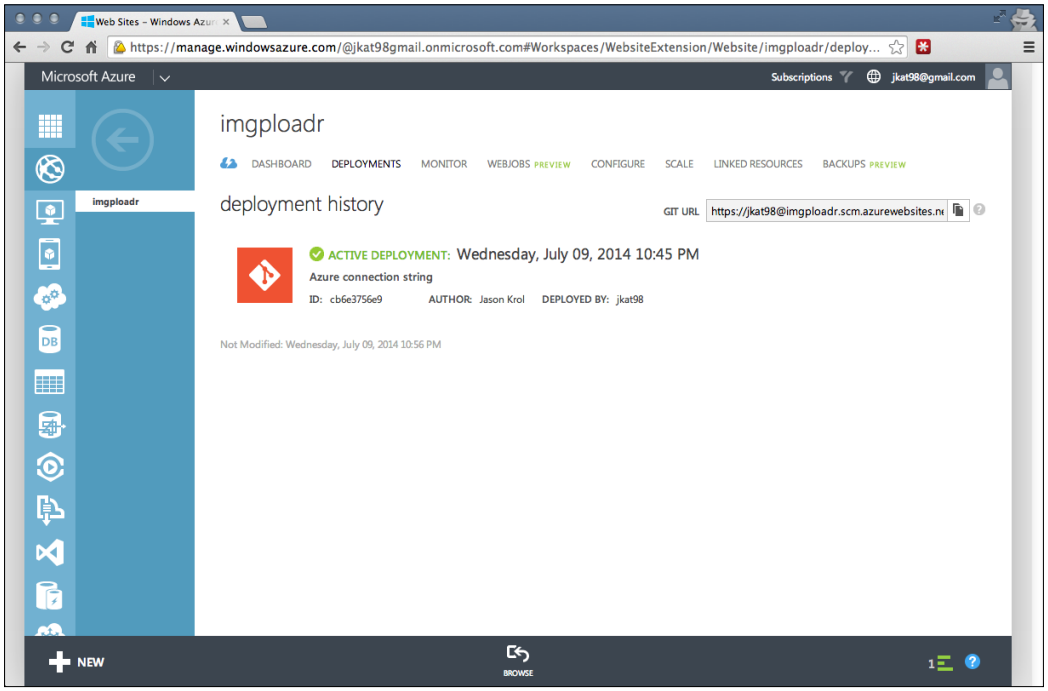


Select **Local Git repository** and then continue by clicking the next arrow icon.

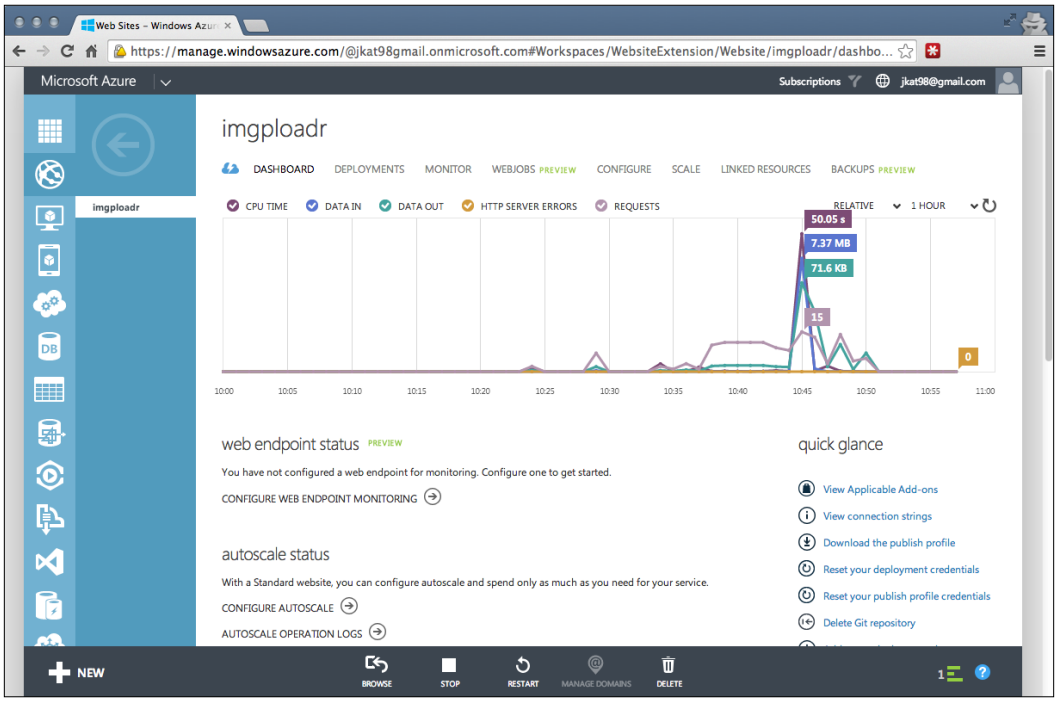
The screen that follows will present instructions on how to push your local code to the remote Git repository that has just been created for your Azure website. The gist is to add a new Git remote (much like we did earlier with Heroku) that points to your Azure repository and then push your code:

```
$ git remote add azure SPECIFIC_URL_FOR_YOUR_SERVER
$ git push azure master
```

You should notice the Git information screen in your Azure dashboard update in real-time as your code starts to push up after the `git push` command. From the command line, you will see a lot of remote `npm install` output as well. Once completed, the deployment history in your Azure dashboard will update showing the information for the last active deployment:



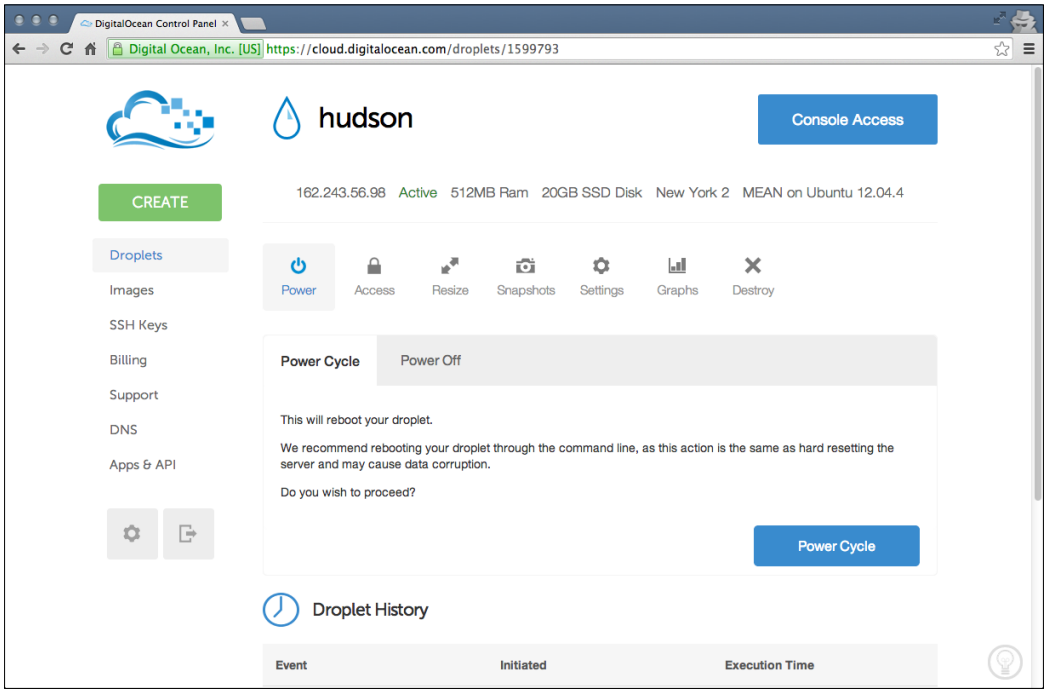
Now that your code has been deployed to your Azure website and your website connection string is pointing to your MongoLab Azure app service, you're ready to give the website a test run! Launch it by pointing your browser to `http://yourappname.azurewebsites.net`:



Azure does a lot of things right (UI/UX) and has some really powerful options and scaling features available! Taking a quick glance at the dashboard for a website (the preceding screenshot) you can see that there is a lot going on! There are many different configuration options as well as health monitoring and general information (FTP settings, website URL, usage metrics, and so on), so feel free to poke around and explore.

Digital Ocean

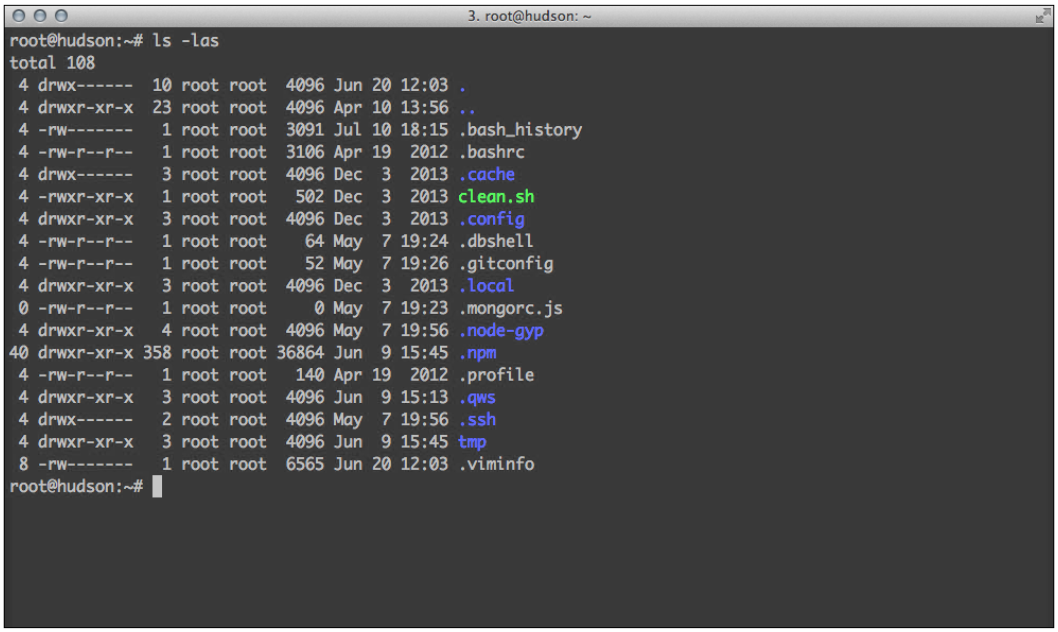
The last service I wanted to mention and briefly take a look at is Digital Ocean `http://digitalocean.com`. Digital Ocean is a true **Virtual Private Server** (**VPS**) service provider and is a good example of a service that gets you just about as "close to the metal" as possible. What this means is that Digital Ocean doesn't really have all the bells and whistles that the other services we've seen offer. What Digital Ocean does offer, however, is direct unfiltered access to the Linux server instance you spin up; in this case, referred to as Droplets:



Digital Ocean allows you to boot up new Linux virtual server instances very quickly. They offer very competitive prices and they're a great service if you need to get a Linux server super fast because you only need one for a short period of time, or you want to boot up your own Linux server that you plan to use to host a production environment. The only "downside" (if I had to refer to it as such) is that you have to be pretty familiar with Linux, specifically administering a server and all the responsibilities that come with that.

You can very easily clone your project using Git on a new Droplet, but an example of the actual raw nature of a new Droplet is that Git is not installed on the server by default. You need to manually install Git before you can clone your repository. Depending on which image you decided to clone when creating a new Droplet, you might need to install and configure Node.js as well as MongoDB. Fortunately, Digital Ocean offers a number of predefined servers you can choose from when creating a new server—one of which includes the **MEAN** (**MongoDB, Express, Angular, and Node.js**) stack. Beyond that, actually launching your app will only run as a process during your currently logged in session—once you log out, your application will go down. You would need to further administer the server to configure your app to run as a service.

Digital Ocean allows you to connect directly to your server using the console access tool within the website itself, or using SSH directly from a terminal on your own machine:



I mention Digital Ocean only because a lot of people will find this kind of raw power quite refreshing and want to do their own hands-on kind of configuration and maintenance of their server. Digital Ocean is an awesome service but it's not for everyone. I wanted to talk about it specifically because I feel that it rounds out and completes the list of services we've covered so far.

Summary

We've covered the full spectrum of cloud-based hosting service providers and walked through configuring your service and deploying your project code. Nodejitsu and Heroku are great services that cater more to developers and give them a lot of power through very accessible and slick user interfaces. Amazon and Microsoft, both industry juggernauts, services are representative of the kind of power and sophistication you'd expect with enterprise-level service providers. Digital Ocean is a no-frills, "close to the metal" cloud-based VPS provider that sacrifices bells and whistles for raw and direct access to the server.

All of the hosting options we covered are great and not the only choices out there. They're just a sample but speak to the power of the Cloud! Within a few minutes and very little to no cost at all, you can have an environment configured, and your website up and running online!

In the next chapter, we will take a look at the concept of Single Page Applications and popular client-side development frameworks and tools.

11
Single Page Applications with Popular Frontend Frameworks

In this chapter, we will take a look at web application development from the frontend perspective, specifically with a **Single Page Application** (**SPA**), also referred to as thick client apps. With SPA, a large chunk of the presentation layer is off-loaded to the browser, and the browser is responsible for rendering pages, handling navigation, and making data calls to an API.

In this chapter, we will cover:

- What exactly a single page application is
- Why use a frontend framework such as Backbone.js, Ember.js, or Angular.js
- Popular frontend development tools such as Grunt, Gulp, Browserify, SAAS, and Handlebars
- Test-driven development on the frontend

What is a Single Page Application?

The current trend with sophisticated web applications is to emulate desktop applications and veer away from the "feel" of a traditional website. With traditional websites, every interaction with the server would require a full-page postback that makes a complete round trip. As our web applications become more sophisticated, the need to send and retrieve data to and from the server increases.

If we rely on full-page postbacks every time we need to facilitate one of these requests, our app will feel sluggish and unresponsive as the user will have to wait for a full, round trip with every request. Users demand more from their apps these days, and if you think about the application we've written, the **Like** button is a perfect example. Having to send a full-page postback to the server just because we wanted to increment a counter by one seems like a lot of unnecessary overhead. Fortunately, we were able to easily rectify this using jQuery and AJAX. This is a perfect example of how a single page application works (only on a much larger scale).

A great example of one of the first, standout single page applications is Google's Gmail. Gmail gives you an interface that is similar to Microsoft Outlook or any traditional desktop-based e-mail client. User interaction with the application feels just as responsive as a desktop application—the "page" never reloads, you can switch panes and tabs within the application with ease, and data is constantly being refreshed and updated in real time.

Creating a Single Page Application typically involves having a single HTML page as the source of the application that loads all of the necessary JavaScript in order to trigger a series of events that include:

- Bootstrapping the app—connecting to the server via AJAX to download the necessary startup data.
- Rendering the screens based on user actions—monitoring events triggered by the user and manipulating the DOM so that sections of the app are hidden, revealed, or redrawn, which emulate the feel of a desktop application.
- Communicating with the server—using AJAX to constantly send and receive data from the server, which maintains the illusion of a stateful connection via the browser.

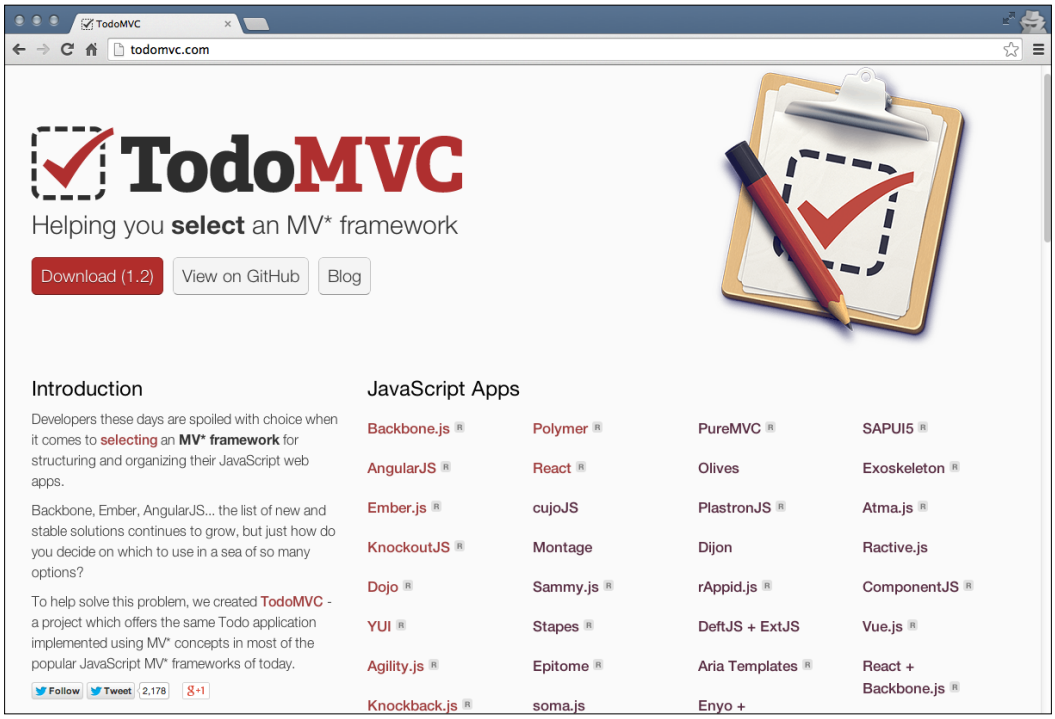
Why use a frontend framework?

We use frameworks to increase our productivity, keep us sane, and generally make our development process more enjoyable. In most of the chapters throughout this book, we worked with the Express.js MVC framework for Node.js. This framework allows us to organize our code and extrapolates out a lot of boilerplate code, freeing up our time to focus on our custom business logic. The same should be said for the front of an application as well. Any amount of complex code is eventually going to need to be properly organized and use a standard set of reusable tools to achieve common tasks. Express.js makes our life easy while writing our backend code with Node.js. There are a number of popular frontend frameworks that you can rely on as well.

The TodoMVC project

When deciding which frontend framework to choose for your next large scale frontend project, the decision-making process can be crippling! Keeping track of all of the different frameworks and the pros and cons of each can seem like an exercise in futility. Luckily, people have answered the call and a handy website exists to not only demonstrate the same application written in nearly every framework, but also to offer the complete annotated source code for each as well!

The TodoMVC project, `http://todomvc.com`, is a website that focuses on creating a simple, single page, to-do application, which is written using each of the proven JavaScript MVC frameworks—there's even one written in vanilla JavaScript!



Definitely spend some time checking out the website and digging into each of the featured frameworks. You can get a really good feel for the different frameworks by seeing the same code written in completely different ways. No two are identical, and ultimately, it's up to you to evaluate and figure out which you prefer and why.

For the sake of brevity, I'm going to focus on the three that I personally like and believe are at the top of the current list of front runners.

Backbone.js

Backbone.js is an extremely lightweight (6.5 Kb in production) MV* Framework that has been around for a few years. It has an extremely large established user base, and many very large-scale web applications have been written using this framework. Some companies that have embraced Backbone.js for development of their flagship products include:

- USA Today
- Hulu
- LinkedIn
- Trello
- Disqus
- Khan Academy
- Walmart Mobile

Backbone.js is a great framework to start with if you're comfortable with jQuery and have been using it for a while and want to start improving your code organization and modularity. Additionally, Backbone.js requires jQuery and integrates it pretty tightly, so that's one less thing to worry about learning as you ease into this new world of frontend development.

Backbone.js works on the basic idea of models, collections, views, and routers. Models are the basic elements that store and manage all of the data in your application. Collections store models. Views render HTML to the screen retrieving dynamic data from models and collections. Routers power the URL of your application, allowing each individual section of your application its own unique URL (without actually loading live URLs) and ultimately tying the whole thing together.

As Backbone.js is so lightweight, an extremely small and simple set of sample code can be put together very quickly:

```
var Person = Backbone.Model.extend();
var PersonView = Backbone.View.extend({
    tag: 'div',
    render: function() {
        var html = [
            this.model.get('name'),
            '<br/>',
```

```
            this.model.get('website')
        ].join('');

        this.$el.html(html);

        return this;
    }
});

var person = new Person({
        name: 'Jason Krol',
        website: 'http://kroltech.com'
    }),
    view = new PersonView({ model: person });

$('body').append(view.render().el);
```

The one thing to notice is that Backbone.js by its very nature is so lightweight that it doesn't include most of the functionalities that you'd expect to work right out of the box. As you can see in the preceding code, in the `View` object that we created, we had to provide a `render` function that manually renders the HTML for us. For this reason, many people shy away from Backbone.js, but others embrace it for the raw power and flexibility it gives to developers.

Traditionally, you wouldn't put all of your code into a single file like the earlier example. You would organize your models, collections, and views into individual folders in a structure, just like how we organized the code in our Node.js application. Bundling all of the code together would be the job of a build tool (discussed later in this chapter).

You can learn more about Backbone.js by visiting its official website at `http://backbonejs.org`.

Also, don't forget to check out the Backbone.js implementation of the to-do application on the TodoMVC website!

I maintain a repository on GitHub that has a boilerplate web application with complete code that uses the full stack we've covered in this book as well as Backbone.js with Marionette for the frontend. Feel free to check it out at: `http://github.com/jkat98/benm` (B.ackbone, E.xpress, N.ode, M.ongoDB).

Ember.js

Ember.js bills itself as the *framework for creating ambitious web applications*. Ember's goal is to target fairly large-scale SPAs so the idea of using it to build something very simple might seem like overkill but is certainly doable. A fair assessment is to take a look at the production file size of the Ember library, which comes in at around 90 Kb (versus 6.5 Kb for Backbone.js). That being said, if you are building something very robust with a very large codebase, the added 90 Kb might not be a big deal for you.

Here is a very small sample application using Ember.js:

```
var App = Ember.Application.create(),
    movies = [{
        title: "Big Trouble in Little China",
        year: "1986"
    }, {
        title: "Aliens",
        year: "1986"
    }];

App.IndexRoute = Ember.Route.extend({
    model: function() {
        return movies;
    }
});

<script type="text/x-handlebars" data-template-name="index">
    {{#each}}
        {{title}} - {{year}}<br/>
    {{/each}}
</script>
```

Ember.js's code looks somewhat similar to that of Backbone.js, and it's no surprise that a lot of seasoned Backbone.js developers find themselves migrating to Ember.js, as their needs for more robust solutions increase. Ember.js uses familiar items, including views, models, collections, and routes as well as an `Application` object.

Additionally, Ember.js features Components, which is one of its more powerful and beloved features. Giving a sneak preview of the future of the Web, Components allow you to create small, modular, reusable HTML components that you can plug into your application as needed. With Components, you can basically create your own custom HTML tags that look and behave exactly how you define them, and they can easily be reused throughout an application.

Developing with Ember.js is all about convention. Unlike Backbone.js, Ember.js tries to get a lot of the boilerplate out of the way and makes certain assumptions for you. Because of this, you need to do things a certain way, and controllers, views, and routes need to follow a somewhat strict pattern with regard to naming conventions.

The Ember.js website features incredible online documentation and getting-started guides. If you're interested in learning more about Ember.js, check it out at `http://emberjs.com/guides/`.

Also, don't forget to take a look at the TodoMVC implementation!

AngularJS

AngularJS exploded onto the scene because of the simple fact that it's built by Google (it is open source). AngularJS is basically like putting HTML on steroids. The applications and pages that you create use regular HTML that we're all used to, but they include a number of new and custom directives that extend the core functionality of HTML giving it awesome new power.

Another great feature about AngularJS that has seasoned non-Web developers flocking to it is that it is built from the group to be heavily tested and supports dependency injection. It's a framework that makes creating sophisticated web applications not feel like traditional web development. This is an extremely robust framework, clocking in at the largest file size of the three we're looking at with 111 Kb of compressed production code:

```
<!doctype html>
<html ng-app>
  <head>
    <script src="https://ajax.googleapis.com/.../angular.min.js"></
script>
  </head>
  <body>
    <div>
      <label>Name:</label>
      <input type="text" ng-model="yourName" placeholder="Enter a name
here">
      <hr>
      <h1>Hello {{yourName}}!</h1>
    </div>
  </body>
</html>
```

You can see by the sample code provided that no custom JavaScript was written at all. Yet the page features real-time data binding between an input field and an `h1` tag. This is stock power and functionality right out of the box, and a demonstration of the extended nature of regular HTML that AngularJS provides.

Make no mistake, however, that JavaScript still plays a huge role in the development of AngularJS. AngularJS features controllers, models, and routes as well as many more features.

Learn more about AngularJS by visiting its website at `http://angularjs.org`.

And take a look at the TodoMVC implementation as well!

Frontend frameworks have recently taken on somewhat religious undertones. Post a negative comment or criticism about a particular framework and it's likely you'll get blasted by its supporters. Likewise, talk positive about a particular framework and, again, it's likely you'll get attacked about how much better a different framework handles the same topic. The bottom line when deciding which framework is right for you and/or your project is typically going to be about personal preference. Each of the frameworks featured on the TodoMVC website can clearly accomplish the same goals, each in its own unique way. Take some time to evaluate a few and decide for yourself!

Frontend development tools

Because of the sophisticated nature of single page applications, there exists a growing suite of tools a frontend developer needs to be familiar with to manage many day-to-day, and sometimes minute-to-minute tasks.

Automated build task managers

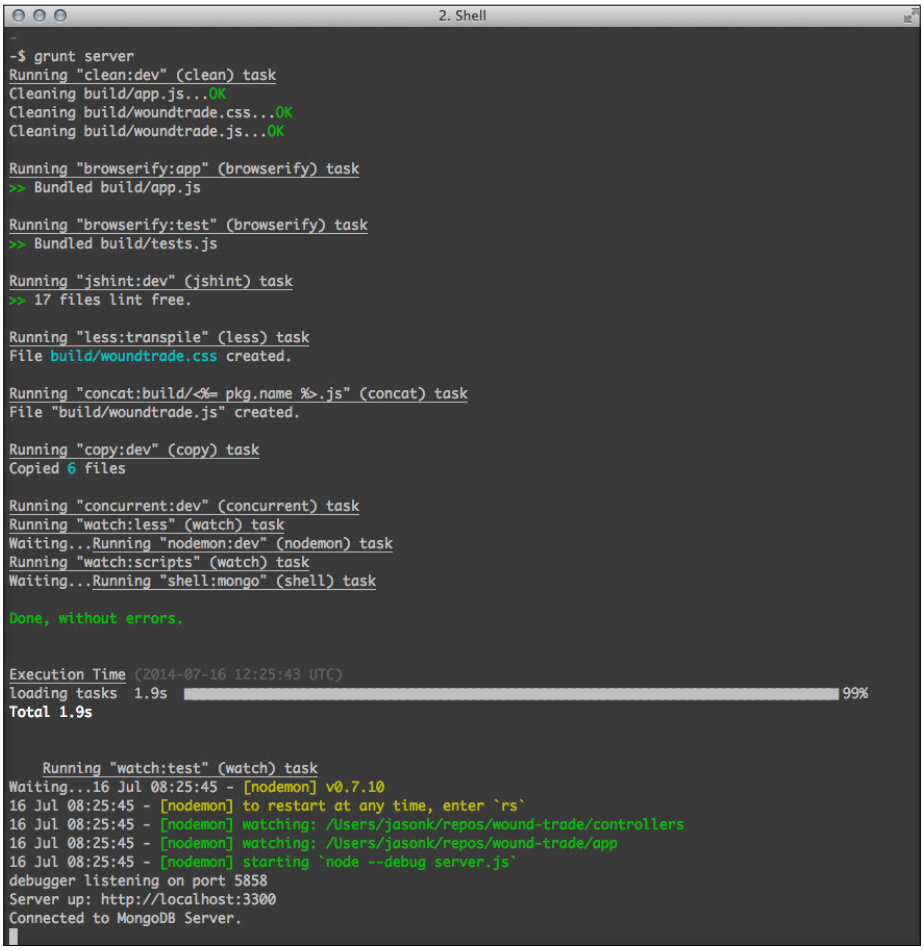
A build tool is just what it sounds like, a tool used to build your application. When a frontend developer creates and maintains an application, there could be a number of tasks that need to be repeated literally every time a file is changed and saved. Using a build tool, a developer can free up time and mental resources by offloading the responsibility to an automated task manager that can watch files for changes and execute any number of tasks needed. These tasks might include any number of the following:

- Concatenation
- Minification
- Uglification and obfuscation
- Manipulation
- Dependency installation and preparation
- Custom script firing
- Concurrent watchers
- Server launching
- Test automation

Some of the more popular build tools today include Grunt, Gulp, and Broccoli. Grunt.js has been around for a number of years and is very well-established in the development community. Gulp and Broccoli are fairly new but quickly gaining traction and work a little differently than Grunt. With Grunt you define and manage your tasks using a configuration file whereas with Gulp and Broccoli you write Node.js code and use the raw power of streams. Many developers find working with Grunt's configuration file to be fairly convoluted and frustrating and find working with Gulp to be a refreshing change. However, it's hard to dispute Grunt's history and popularity.

All three feature extensive ecosystems of plugins that help automate literally everything and anything you can think of with your build process.

Here is some sample output from a typical Grunt build command:



In a typical single page application, the build manager can be responsible for: downloading and installing dependencies, concatenating multiple JavaScript files into a single file, compiling and shimming Browserify modules, linting JavaScript files for syntax errors, transpiling LESS files into production-ready CSS files, copying files to a runtime destination, watching files for changes to repeat any of the tasks again, and finally running appropriate tests any time the code is changed—all from a single command!

Grunt can be installed using npm and should be installed globally. Execute the following command to install the Grunt CLI on your machine:

```
$ npm install -g grunt-cli
```

Refer to the getting-started guide on the official Grunt.js website for more information at http://gruntjs.com/getting-started.

Additionally, feel free to check out Gulp and Broccoli as well for more information:

`http://gulpjs.com/`

`https://github.com/broccolijs/broccoli`

Dependency management

There are literally millions of JavaScript libraries that exist to help you with everything from DOM manipulation (jQuery) to timestamp formatting (moment.js). Managing these libraries and dependencies can sometimes be a bit of a headache. For the frontend, the dependency manager of choice is Bower.io.

Bower works almost exactly the same way as npm. While working on the frontend, and you need a known JavaScript library or plugin (such as underscore, for example), simply execute `bower install underscore` and the JavaScript files will be downloaded to a local `bower_components` folder in your project. From there, you can automate the inclusion of those scripts by updating your build process, or simply copy the file, include a script tag in your HTML, and you're all set.

Bower can be installed using npm and should be installed globally. Execute the following command to install Bower on your machine:

```
$ npm install -g bower
$ bower install jquery
bower cached        git://github.com/jquery/jquery.git#2.1.0
bower validate      2.1.0 against git://github.com/jquery/jquery.git#*
bower new           version for git://github.com/jquery/jquery.git#*
```

```
bower resolve       git://github.com/jquery/jquery.git#*
bower download      https://github.com/jquery/jquery/archive/2.1.1.tar.gz
bower extract       jquery#* archive.tar.gz
bower resolved      git://github.com/jquery/jquery.git#2.1.1
bower install       jquery#2.1.1
jquery#2.1.1 bower_components/jquery
```

Visit the Bower.io website (`http://bower.io`) for more information as well as the full directory of scripts available to be installed via `bower install`.

Modularity

When writing large JavaScript applications, the key is to keep your source code well-organized and structurally sane. Unfortunately, JavaScript doesn't inherently support the idea of modular code very well right out of the box. To solve this problem, two popular libraries exist to allow you to write modular code and rely on only the modules you need within each individual piece of code.

An absolute must-read and incredible resource for frontend design patterns is Addy Osmandi's *Learning JavaScript Design Patterns*, which you can read for free by visiting the following URL:
`http://addyosmani.com/resources/essentialjsdesignpatterns/book/`

Require.js and Browserify are two of the most popular module loaders today. Each has a very unique syntax and its own set of benefits. Personally, I've worked with Require.js in the past, and recently I've found that I really like working with Browserify. One of Browserify's strengths is that it uses the same modular pattern as Node.js; so, writing frontend code using Browserify feels identical to that of Node. You use `module.exports` and `require` on the frontend, and you don't have to worry about syntax context switching if you go back and forth between Node and the frontend within the same application.

Using a module loader in conjunction with one of the popular MVC frameworks mentioned earlier is almost a requirement because the two go together like peanut butter and jelly!

For more information, visit the following links:

- `http://browserify.org/`
- `http://requirejs.org/`

HTML template-rendering engines

Fortunately, we've covered the idea of HTML template-rendering engines already throughout the course of this book. The topics and concepts transfer directly to frontend applications as well. There are many different HTML template engines to choose from for use in the browser.

Many template engines will be mustache-based, meaning they use {{ and }} for merge variables. Handlebars is currently my personal favorite, mainly because it works so well in the backend and frontend of an application, and I really like working with its helpers. Underscore.js has a built-in "lite" template-rendering engine for use with Backbone.js, but its syntax uses `<%` and `%>` (much like classic ASP or ASP.net MVC Razor syntax). Typically, most frontend MVC frameworks allow you to customize the template-rendering engine and use any engine you want. For example, Backbone.js can be very easily set up to use Handlebars.js instead of underscore.js by default.

Here's just a small sample list of some of the currently available frontend template-rendering engines:

- **Underscore.js**: `http://underscorejs.org`
- **Handlebars**: `http://handlebarsjs.com`
- **Mustache**: `http://mustache.github.io`
- **Dust.js**: `http://akdubya.github.io/dustjs`
- **EJS**: `http://embeddedjs.com`

Some of these will work at the backend as well as on the frontend.

CSS transpiling

The idea of using variables and logic within a CSS file sounds like a dream come true, right? We aren't quite there yet (in the browser anyway), however there are a few tools that will let us use variables and logic in our CSS files and compile them during our build step. LESS and SASS are two of the most popular CSS transpilers currently available. They behave almost identically, with only slight differences in syntax and features. The big difference is that LESS was written using JavaScript and Node, whereas SASS uses Ruby; therefore, each has different requirements to get running on your machine.

Here is a sample SASS style sheet file:

```
$sprite-bg:url("/images/editor/sprite-msg-bg.png");

@mixin radius($radius) {
  -moz-border-radius: $radius;
  -webkit-border-radius: $radius;
  -ms-border-radius: $radius;
  border-radius: $radius;
}

.upload-button {
    border-bottom: solid 2px #005A8B;
    background: transparent $sprite-bg no-repeat;
    @include radius(4px);
    cursor: pointer;
}

#step-status {
    color:#dbdbdb; font-size:14px;

    span.active {
        color:#1e8acb;
    }

    &.basic-adjust, &.message-editor {
        width: 525px;
    }

    .icon {
        height:65px;
        width: 50px;
        margin:auto;
    }
}

@import "alerts";
@import "attachments";
@import "codemirror";
@import "drafts";
```

Looking at the sample code, you can see that we have a few new elements that wouldn't typically work in a regular CSS file. Some of these include:

- Defining custom variables for use throughout the style sheet
- Defining mixins, which act as pseudo functions for reusable styles (with dynamic parameters)
- Including mixins and variables within our style definitions
- Nesting styles with parent/child relationships

When the previous code is transpiled using LESS (or in the case of the sample code SASS), the output is a standard `.css` style sheet that adheres to all the normal browser rules and syntax.

For more information on LESS and SASS, check out the following links:

- `http://lesscss.org`
- `http://sass-lang.com`

Testing and test-driven development

The development of a sophisticated frontend application is no different than any other software application. The code is going to be complicated and robust, and there's no reason not to write tests as well as practice test-driven development. The availability of testing frameworks and languages for the frontend is just as robust as any other language. All of the tools and concepts we've used for testing the Node.js code that we've written in this book can be used directly on the frontend as well.

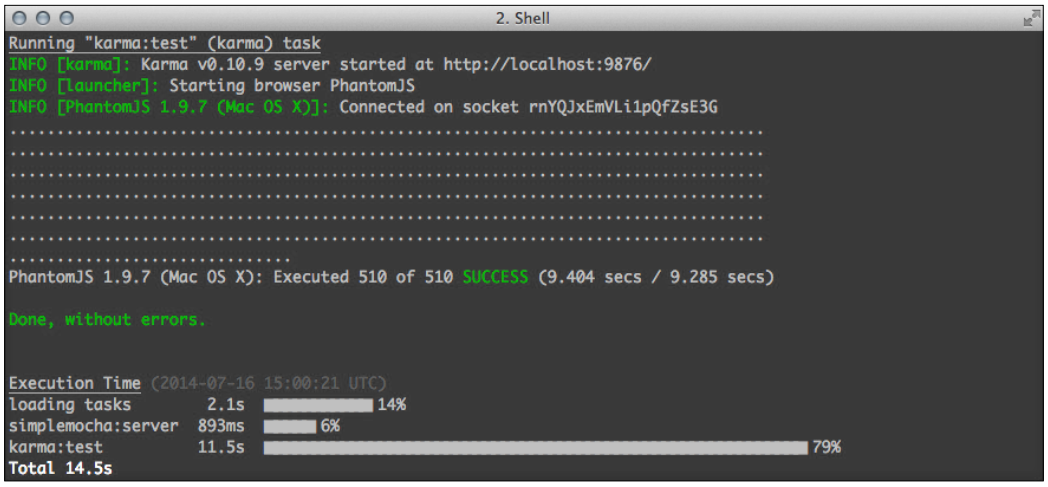
Some other tools to consider for testing your frontend JavaScript are:

- **Karma for running tests**: `http://karma-runner.github.io`
- **Jasmine for writing tests**: `http://jasmine.github.io`

PhantomJS headless browser

One thing I'd like to point out with testing frontend code is that typically the test runners want to run in a browser window. This is great and makes perfect sense, but in the real world, automating your tests or quickly executing them with TDD can be a bit painful when a browser window wants to open every time your test suite runs. PhantomJS is a *headless* browser available that works perfectly in this kind of scenario. A headless browser simply means it's a browser that runs from the command line, in memory, with no actual interface (like a typical browser).

You can easily configure Karma to launch the test suite using PhantomJS instead of your browser of choice. When using PhantomJS as your browser, your tests execute behind the scenes and only errors are reported. Here is a sample output of a test suite running with Karma using PhantomJS:



Summary

This was a whirlwind tour of some of the most common frontend tools and frameworks used when doing typical web development. We took a look at the TodoMVC project and reviewed three popular JavaScript frameworks to build robust and sophisticated frontend applications.

Popular build tools such as Grunt.js, Gulp, and Broccoli help developers streamline their workflow process by automating a lot of the repetitive tasks that need to occur every time a file is modified. From concatenating scripts into a single file to minifying and compressing to executing automated test suites, the task runners can be configured to handle pretty much everything under the sun!

We took a look at two popular CSS transpilers with LESS and SASS and saw how they can make creating and managing CSS style sheets dynamic with the use of mixins, variables, and nesting.

Finally, we learned about PhantomJS, the headless browser, and using it when running frontend tests so that the tests can be executed quickly and easily from the command line using a test runner like Karma.

In the next and final chapter, we'll review some alternative frameworks to develop web applications using Node.js and MongoDB.

12
Popular Node.js Web Frameworks

Throughout this book, we've focused exclusively on using Express.js as our web framework of choice, primarily because it's one of the most popular web development frameworks for Node, has been around for quite a while, and is very widely used. However, there are a number of alternate frameworks available that I want to introduce to you. Some of these frameworks are much more powerful and robust than Express.js, while others are right in line or slightly less feature packed.

Most of the frameworks that exist today and discussed in this chapter are still in their early stages of development; some have not even reached a 1.0 status. The use of these in a production environment should be considered carefully and under a fair amount of scrutiny.

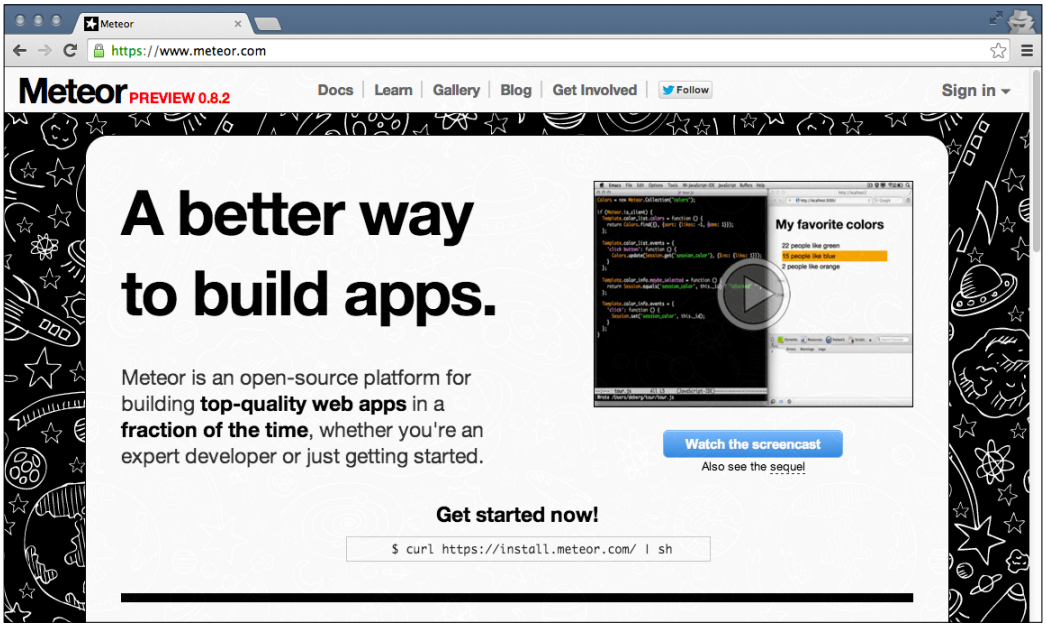
In this chapter, we will take a brief look at the following frameworks:

- Meteor
- Sails
- hapi
- Koa
- Flatiron

Meteor

Meteor is a simple, complete web framework with the goal of giving developers of any skillset the ability to build robust web applications in a fraction of the time. Meteor is pretty close to what we've used throughout this book—it relies exclusively (at the time of writing) on MongoDB as a primary data store and uses Handlebars for HTML templates. It features a handy CLI tool that you can use to scaffold new projects very quickly.

The Meteor website (`http://meteor.com`) is shown in the following screenshot:



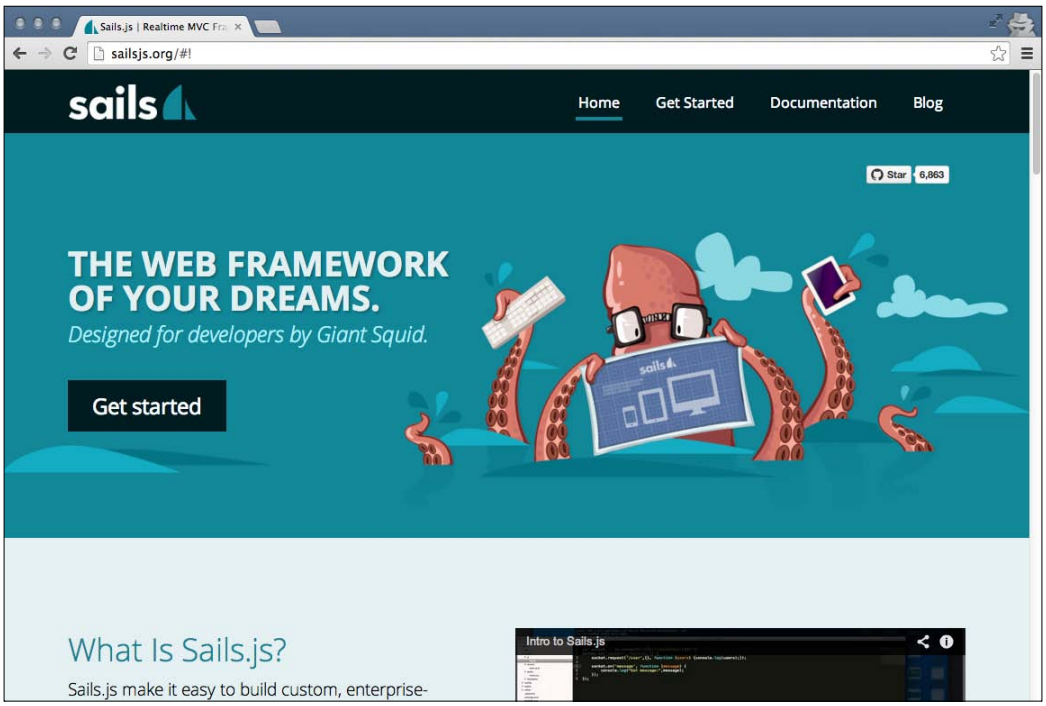
It is quickly gaining traction and becoming increasingly popular every day—currently, its GitHub repo has over 17,000 stars!

More information about Meteor can be found on its website as well as its official GitHub repo at `https://github.com/meteor/meteor`.

Sails

Sails is another great MVC framework for building web applications using Node.js that sometimes compares itself to Ruby on Rails. Unlike Meteor, Sails is database agnostic, so it doesn't matter which data store you choose. Sails includes some handy scaffolding tools such as automatic RESTful API generation. Socket.io, a real-time communication framework for Node.js, is built into Sails; so, including real-time functionalities in your application should be a breeze. Sails features some nice production-level automation that would typically need to be handled by a tool such as Grunt.js or Gulp (this includes minification and bundling of CSS and JavaScript for the frontend). Sails also includes basic security and role-based authentication for your app should you require that level of functionality.

The Sails website (`http://sailsjs.com`) is shown in the following screenshot:

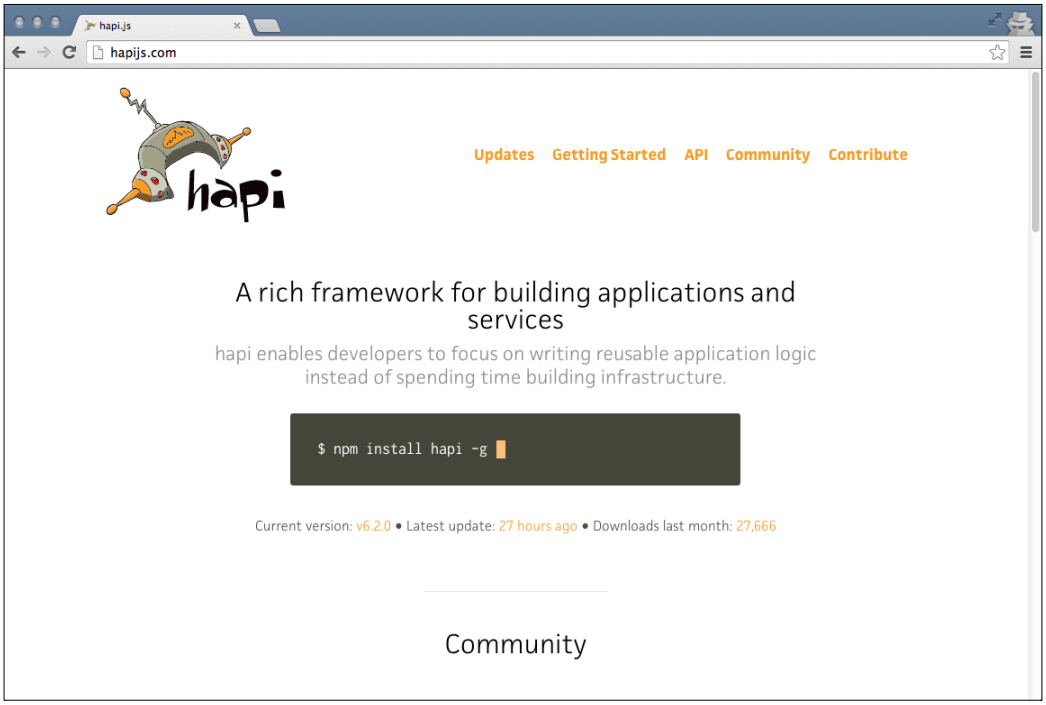


More information about Sails can be found at its website as well as its official GitHub repo at `https://github.com/balderdashy/sails`.

hapi

hapi is the result of the team behind Walmart's online mobile website. The team that built that website developed a rich set of Node.js utilities and libraries that can be found under the Spumko umbrella. Considering the tremendous amount of traffic Walmart's website receives on any given day, it's no wonder that the team at WalmartLabs is at the top of their game when it comes to Node.js development and best practices. hapi is the web framework that was born from the ashes of real-world trial and error.

The hapi website (`http://hapijs.com`) is shown in the following screenshot:



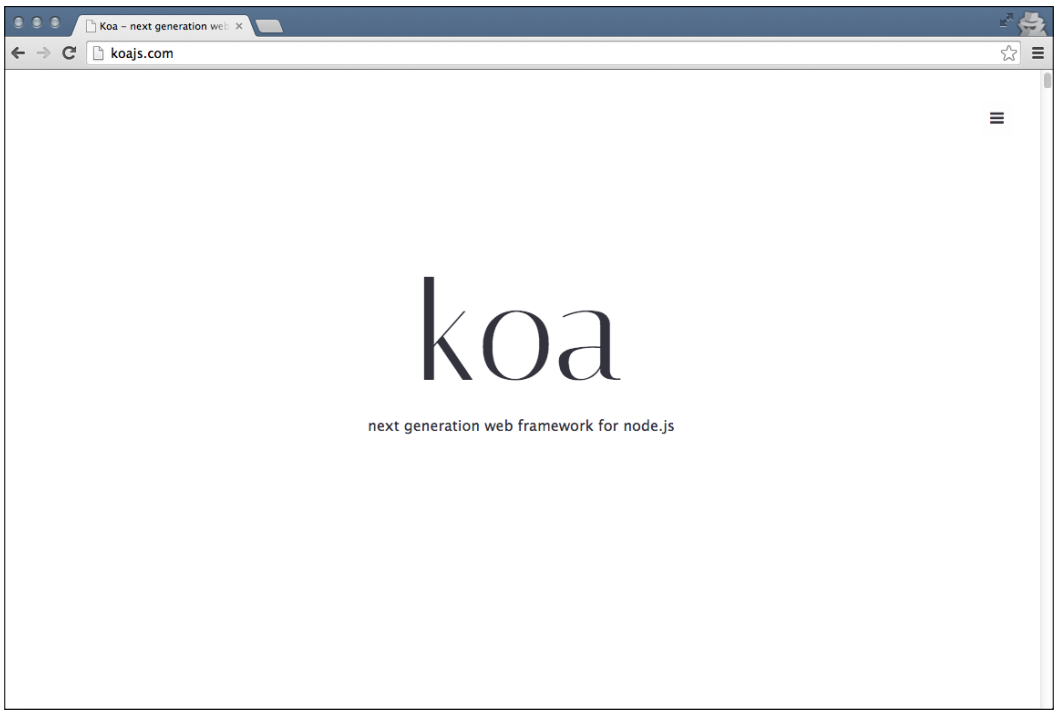
More information about hapi can be found at its website as well as its official GitHub repo:

`https://github.com/spumko/hapi`

Koa

Koa is a new web framework designed by the same team that created Express.js. The goal of Koa is to be smaller, more expressive, and a more robust foundation for web applications. One of the key features of Koa is the use of generators, which is a feature found in other popular programming languages such as Python, C#, and Ruby, and it is coming soon to JavaScript with ECMAScript 6 (the next version of JavaScript). Generators prevent the standard *callback hell* that is so popular with the development process in Node.js. As Koa is so lightweight, it does not come with any middleware out of the box. This is by design so that the choice of how to implement certain features can be left to the developer.

The Koa website (`http://koajs.com`) is shown in the following screenshot:

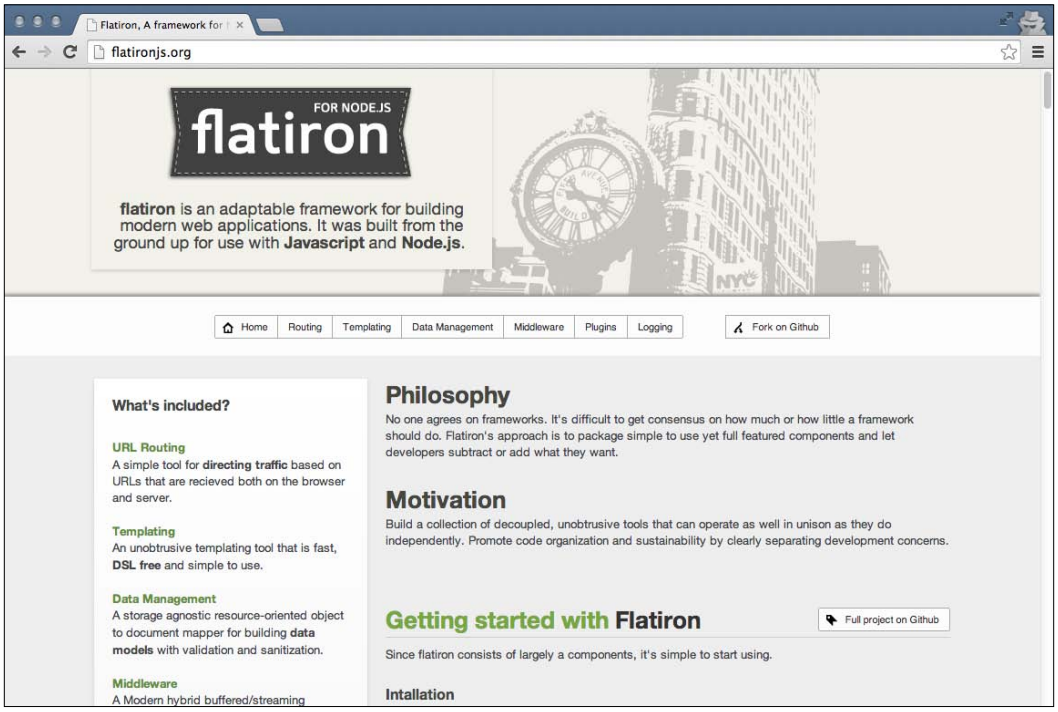


More information about Koa can be found on its website as well as its official GitHub repo at `https://github.com/koajs/koa`.

Flatiron

Flatiron is yet another Node.js MVC web application framework. What sets Flatiron apart from other frameworks is its package-based approach. Since it gives the power and freedom to decide how much or how little the framework should include, developers can pick and choose the packages they want to work with and include with their project. It handles a lot of the basic data management responsibilities and CRUD for you by supplying a powerful ODM that takes care of a lot of the heavy lifting.

The Flatiron website (`http://flatironjs.com`) is shown in the following screenshot:



More information about Flatiron can be found on its website as well as its official GitHub repo at `https://github.com/flatiron/flatiron`.

Summary

Even though we used Express.js exclusively throughout this book, there are many other options available when creating web applications using Node.js. We examined a few of those options in this chapter, including Meteor, Sails, hapi, Koa, and Flatiron. Each framework features its own strengths and weaknesses and its own unique approach to the standard functionality a web application requires.

The beauty of web development with Node.js is that there's no shortage of opinions on how to accomplish a single task. MVC frameworks are no exception, and you can see from this chapter there are a lot of really robust and feature-packed frameworks to choose from.

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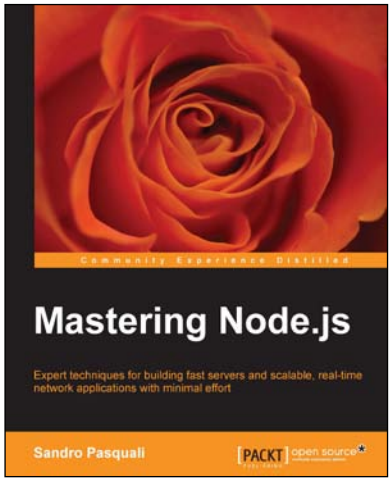

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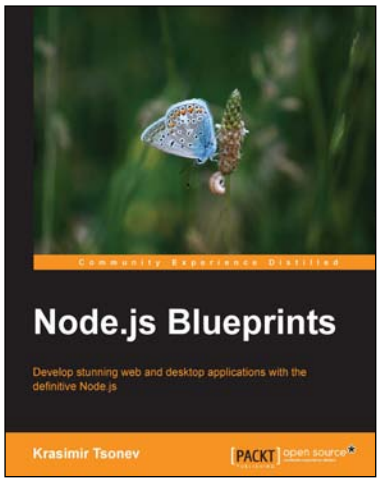

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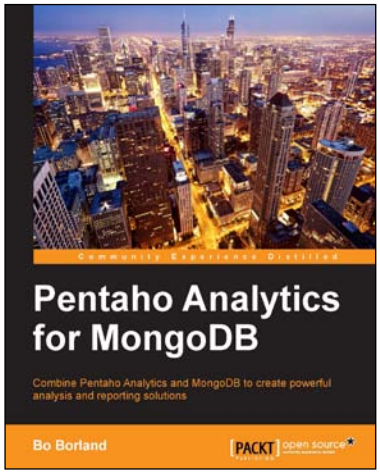

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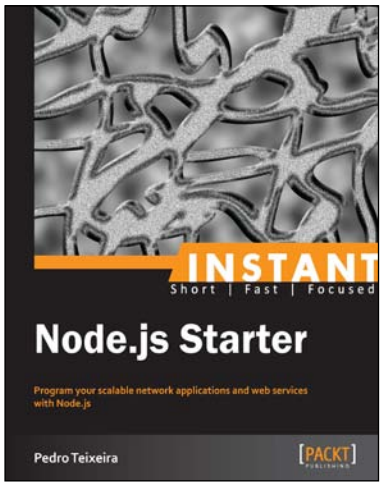

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